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ABSTRACT

The public has become increasingly aware that marine wildlife sometimes becomes entangled in fishing gear, such as dolphins in tuna nets. However, little is known about how widespread entanglement is and what its impacts are. If conclusions can be drawn from what few data do exist, the picture is an alarming one. Each year fishing activity causes the death of many thousands of marine mamals, sea birds, and sea turtles. Many of the species killed are already endangered or threatened. By consolidating the diverse information on entanglement this report assesses how and why incidental take of marine animals occurs. Because data are scarce and scattered, the issue was researched by starting with known entanglements and then examining the fisheries in which they occurred. The report summarizes each fishery by target species, gear used, area of operations, level of effort, and the kinds of entanglements caused by recreational fishing, discarded or lost gear and other debris, and ingestion of plastic debris by marine wildlife. (CW)

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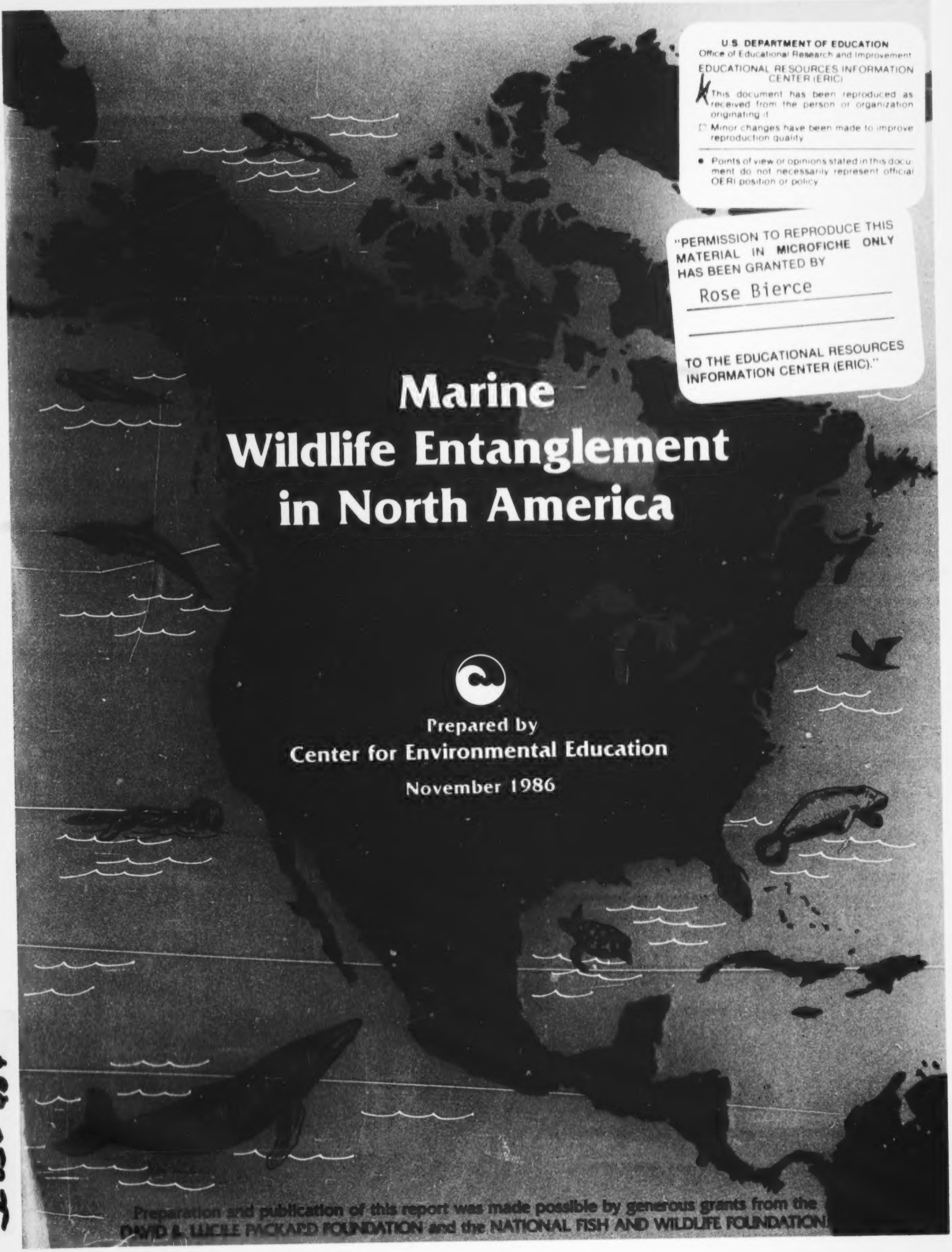

Marine Wildlife Entanglement in North America

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MARINE
WILDLIFE ENTANGLEMENT
IN NORTH AMERICA

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Center for Environmental Education

November 1986

Authors: Kathryn O'Hara
Natasha Atkins
Suzanne Iudicello

with: Susie G. Criswell
and Rose Bierce

Maps and cover design: Jill Perry

EXECUTIVE SUMMARY

The public has become increasingly aware that marine wildlife sometimes becomes entangled in fishing gear, such as dolphins in tuna nets. However, little is known about how widespread entanglement is and what its impacts are. If conclusions can be drawn from what few data do exist, the picture is an alarming one: each year fishing activity causes the death of many thousands of marine mammals, seabirds and sea turtles. Many of the species killed are endangered or threatened.

Laws exist to protect these species, specifically the Endangered Species Act, the Marine Mammal Protection Act and the Migratory Bird Treaty Act. However, existing legislation contains numerous provisions allowing incidental take of marine wildlife. Moreover, preventing illegal take is often hampered by the difficulty of enforcement or by a reluctance to enforce regulations. While observer programs could provide enforcement, monitoring, or at the very least a better picture of the magnitude of incidental capture, these programs exist only for foreign fisheries operating in the U.S. Fishery Conservation Zone (FCZ). The vast U.S. fishing industry operates largely without observation or any requirements for reporting incidental take, and U.S. fishermen are increasingly entering fisheries that previously had been the domain of foreign fleets. Given these considerations, the extent of incidental take of marine species in fisheries is indeed disturbing.

By consolidating the diverse information on entanglement this report assesses how and why incidental take of marine animals occurs. Because data are scarce and scattered, the issue was researched by starting with known entanglements and then examining the fisheries in which they occurred. The report summarizes each fishery by target species, gear used, area of operations, level of effort, and the kinds of entanglements that have been known to occur. The report also discusses entanglement caused by recreational fishing, discarded and lost gear and other debris, and ingestion of plastic debris by marine wildlife.

It is the hope of the authors that a discussion of the various laws, policy, research, and enforcement considerations applicable to entanglement, will offer some hope for addressing the problem, particularly in view of the fact that the Marine Mammal Protection Act will be up for reauthorization in 1988. The report should prove to be a useful tool during the reauthorization process to address existing gaps in legal protection of marine wildlife.

COMMERCIAL FISHERIES IN THE ATLANTIC OCEAN AND GULF OF MEXICO

Fisheries of the Northeast

The New Brunswick herring fishery is conducted with the placement of weirs along coastal New Brunswick, in the Bay of Fundy, and along coastal Nova Scotia. Harbor porpoise entanglement in the weirs has been documented. Similar problems occur with the Newfoundland herring weir fishery. Other Newfoundland fisheries are the cod, groundfish, and salmon fisheries. The cod and groundfish fisheries are conducted inshore with traps which frequently entangle humpback, minke, and fin whales. Entanglement of Atlantic white sided dolphins and harbor porpoises have been documented. The salmon drift gill net fishery has also been observed to entangle humpback, minke, and fin whales, harp seals, the occasional leatherback turtle, and many seabirds.

The increased demand for and high price of American lobster has led to increased effort in this fishery which occurs in inshore waters from Maine to New Jersey, and in the Outer Continental Shelf from New England to North Carolina. Cetaceans, including endangered and threatened species, have become entangled in the traps and lines. Localized occurrences of entanglements of seals and sea turtles have been reported, as has the occasional trapping of cormorants.

The Northeast groundfish fishery takes cod, haddock, yellowtail flounder, hake and pollock in set gill nets averaging more than 10,000 feet in length. The nets are left unattended on the fishing grounds which stretch from the Gulf of Maine to Georges Bank and to southern New England. The gill nets have been observed to entangle harbor porpoises, Atlantic white-sided dolphins, pilot whales, and harbor seals. Endangered species that have been taken in the nets include humpback, finback and right whales. The fishery operates under a Small Take Letter of Exemption, which requires reporting to the University of Maine of marine mammals captured.

The most important gear type in the Northeast Atlantic is the otter trawl, which is used to take groundfish including flounder, haddock, whiting, redfish and cod. This fishery occurs year round, inshore and offshore, from the Gulf of Maine to Georges Bank. Three entanglements of cetaceans have been reported: a harbor porpoise, a humpback whales, and a common dolphin. Strandings of seven Kemp's ridley turtles have been reported, but there was no conclusive evidence that the strandings were related to the trawl fishery.

Of decreasing importance among the New England fisheries is the longline fishery for cod, cusk, haddock, white hake, halibut, and pollock. Massachusetts and Maine fishermen are the largest remaining users of this type of gear. There have been three known entanglements on longlines: two humpback whales and a leatherback turtle, as well as occasional snaggings of harbor seals.

Purse seines, stop seines and weirs are used to fish for herring in the Gulf of Maine, Georges Bank, and off the Scotian shelf, and south to southern New England and the mid-Atlantic. The fishery follows the seasonal migrations of the herring. Weirs have been reported to take one right whale and calf, one humpback, and one Kemp's ridley turtle. Purse seines commonly entangle seals and dolphins.

The squid and mackerel fisheries in the northeast are conducted by both domestic and foreign fishermen as well as joint ventures between U.S. vessels and foreign fleets. The fishery operates in the mid-Atlantic Bight and from the Gulf of St. Lawrence south to Delaware Bay. The trawl gear takes primarily common dolphins and pilot whales, but also has been observed to take Atlantic white-sided dolphins, bottlenosed dolphins, Risso's dolphins, and a right whale. Permits for incidental capture are required in this fishery, and observers are stationed aboard the foreign vessels. The boats usually capture the permitted quota of marine mammals, then reapply to receive a quota for additional animals. There are no permits required for the U.S. fleet and no observers aboard the U.S. vessels, so incidental take by the domestic fleet is not counted against the quota unless a mammal is inadvertently delivered with fish to a foreign vessel and tallied by an observer.

Fisheries of the Mid-Atlantic

Approximately 100 pound net fishermen operate in the eastern portion of Long Island, New York, targeting Atlantic mackerel, sea trout, bluefish and a variety of other species from early spring through fall. Recent evidence indicates that sea turtles, particularly Kemp's ridleys, are regularly entrapped in pound nets. As many as 20 animals per fisherman may be caught each year.

Off the coast of Delaware fishermen use set and drift gill nets to take sea trout, striped bass, bluefish, croaker, white perch and shad. The fishery has been reported to take loggerhead and Atlantic ridley sea turtles.

Pound nets, haul seines and gill nets are the gear choices for taking Chesapeake Bay finfish, including alewives, bluefish, croaker, spotted shad, butterfish, sea trout, white perch, and striped bass. The Virginia pound net fishery in the Bay coincides with the period of greatest abundance of sea turtles, with reported mortality of loggerhead, Atlantic ridley, and leatherback turtles. The entanglement of bottlenosed dolphins also is reported occasionally. The gill net fishery has been reported to entangle humpback and minke whales, bottlenosed dolphins and large numbers of waterfowl.

The shad and sturgeon fishery uses set and drift gill nets off the coasts of North Carolina, South Carolina and Georgia. This gear reportedly has entangled dolphins, turtles, porpoises, seabirds and waterfowl.

Fisheries of the Southeast Atlantic and Gulf of Mexico

The U.S. menhaden fishery is the largest in the country in terms of volume and value. These fish are taken in purse seines from Canada to the northern border of Florida and in the Gulf of Mexico. They are used primarily for the production of meal, oil and solubles. The National Fish Meal and Oil Association, which represents companies that harvest and process menhaden, received a Small Take Letter of Exemption from the National Marine Fisheries Service allowing permit holders to capture certain species of non-depleted marine mammals incidental to their operations in the North Atlantic and Gulf. However, the Association reported no mammals taken in 1984. Available information indicates that more animals are taken in the menhaden fishery than are reported, and that fishermen will not report incidental takes unless they are observed by federal observers. Based on surveys of knowledgeable individuals, it is estimated that as many as 30 dolphins drown per year in these purse seines. Others have noted that sea turtles are often caught in menhaden purse seines, but documentation is not available.

Off the coast of Florida, crab trap float lines present a potential hazard to West Indian manatees, an endangered species, that forage along the bottom of shallow coastal waters. Florida is the sole producer of stone crabs in the U.S., with two major trap fisheries using two-foot-square mesh traps. In a ten year period, more than 30 manatees were known to be entangled, several of which died. Several remedies have been suggested, including a prohibition against crab trapping in the Merritt Island National Wildlife Refuge.

Swordfish are caught off the east coast and the Gulf of Mexico, primarily on monofilament longlines, sometimes as long as 40 miles. The lines are suspended below the surface, with hooks attached to evenly spaced vertical lines that hang from the main line. Based on observer files from the Japanese tuna longline fleet operating in the Atlantic FCZ, it was extrapolated that the longline fisheries captured 126 sea turtles in the Atlantic and 204 in the Gulf. However, these data do not correlate with observed incidental take of turtles by a swordfish longline vessel fishing in the Grand Banks area. It appears that the different style of longline configuration used by the Japanese tuna fishery does not give an accurate picture of incidental capture by the swordfish longliners, and more monitoring is needed to assess the magnitude of take in this fishery. However, the swordfish fishery is a domestic effort for which no observer program is required, making such monitoring difficult. Further exacerbating the problem is the introduction of drift gill nets in the northeast, which can be expected to increase incidental takes, based on the history of incidental takes of marine mammals in the California drift gill net fishery after which the swordfish gear was patterned.

Shrimp support the most valuable fishery in the United States, but it is a fishery whose incidental catch poses a serious threat for endangered species. Each year the U.S. shrimp fishery incidentally catches and drowns thousands of sea turtles in trawl nets in the southeast Atlantic and Gulf of Mexico, most of them juvenile loggerhead turtles. Kemp's ridleys, which are critically endangered with perhaps fewer than 520 adult females remaining, are taken in both inshore and offshore shrimp fishing operations. Juvenile Kemp's ridley turtles are primarily caught in shallow water where they feed, and adults are taken in all areas during their migration between feeding areas and nesting sites in Mexico. The shrimp fishery in the southeastern United States is also suspected of killing several bottlenosed dolphins every year. Research has proven that the Trawling Efficiency Device virtually eliminates incidental drowning of sea turtles and improves the quality of the trawl catch. However, despite the proven qualities of the TED in eliminating bycatch, enhancing shrimp catch, and preventing sea turtle drownings, fewer than one percent of the fleet are using the device. Efforts are currently underway to mandate its use through federal regulation.

COMMERCIAL FISHERIES OF THE PACIFIC OCEAN

Fisheries of California

Of all California's fisheries, the gill net fisheries have expanded most rapidly and are the most diverse in terms of species harvested. Principal species taken in gill nets include shark, California halibut, white seabass, rockfish, white croaker, California barracuda, Pacific bonito, flyingfish and inshore aggregate species. Gear types include set and drift gill nets as well as trammel nets, with the type varying according to target species, location, season, and state and local regulations. Annual incidental take in all California gill net fisheries combined includes a minimum of 100 sea otters, 1,000 California sea lions, 100 harbor seals, and possibly up to 25 elephant seals, 30 pilot whales and an unknown number of gray, humpback and finback whales which drown each year in gill and trammel nets statewide. In addition, the halibut and croaker fisheries of Central California annually take as many as 300 harbor porpoises and thousands of seabirds--25,000-30,000 in one exceptional year. Efforts are underway presently to modify fishing regulations restricting use of gill nets in areas where they have proven to be most detrimental to seabirds and marine mammals.

Purse seines, lampara nets and gill nets are used off the California coast for the Pacific herring roe fishery. The fishery operates in the winter in San Francisco Bay, Tomales Bay, Bodega Bay, Humboldt Bay and in the Crescent City Harbor. Restrictions on the size of gill nets have alleviated some marine mammal entanglements, which were more frequent when drift gill net fishing was permitted. California sea lions have been reported to become entrapped and drown in round haul nets, but the overall estimated mortality of sea lions is minimal.

Round haul nets and purse seines also are used in the California squid, mackerel, tuna, herring and anchovy fisheries. The commercial squid fishery has operated in Monterey Bay and areas of southern California. The California sea lion is the major species involved in interactions with the round haul net fisheries but estimates on total mortalities were unavailable. Other reports of marine mammals taken in these fisheries include gray whales, harbor porpoises, and pilot whales.

Trawl gear is used in California for rockfish and deep water flatfish, southern California halibut, hake and widow rockfish, and shrimp. California sea lions, attracted to the fish caught in a trawl, often follow fishing boats and may become entrapped in the net, but total mortality attributed to this fishery has not been studied. Elephant seals have been observed trailing pieces of trawl fragments presumably encountered as debris rather than as actively fished gear.

Fisheries of the Northwest and Alaska

Dungeness crabs are harvested in traps or pots in all major coastal ports of Oregon and Washington. Gray whales are the cetacean most commonly reported entangled in fishing gear along the Oregon coastline, and most of these entanglements are associated with crab traps. In recent years the number of gray whale strandings reported in Oregon and Washington has been unusually high, with 27 each year in 1983 and 1984. Although the crab trap fishery may not be the primary cause of mortality, additional monitoring should be considered to see how this fishery contributes to overall mortality.

Some of the most valuable fisheries of the Pacific Coast are the salmon fisheries of Oregon and Washington, which primarily harvest chinook and coho salmon. Salmon are taken mainly from the Columbia River and in coastal waters. In the Columbia River and coastal waters of Washington, drift gill nets are the primary type of gear used, although salmon are also taken by purse seines and trolling. More than 2,000 gill net vessels were operating in these fisheries in 1981. Only treaty Indians may use set gill nets and dip nets on the Columbia River. Hundreds of animals are killed in these fisheries every year, although harbor seals are the species most frequently taken, either by entanglement in nets or by explosives and firearms used to deter seals, which compete for the salmon and damage fishing gear. Seals caught in nets usually either drown or are clubbed or shot by fishermen. Other species taken include California and northern sea lions, northern fur seals, elephant seals, and cetaceans. More than 4,000 gill net and troll fishermen operate under a permit to take almost 2,000 pinnipeds and 200 cetaceans. A potential problem is the recent development of a sturgeon gill net fishery, which results in takings in excess of the quota. Mortality of seabirds, primarily murres and grebes, may be a serious problem, but this has not been adequately studied.

The gill net fishery of Barkley Sound, British Columbia, targets sockeye salmon using multifilament nylon gill nets from 440 to more than 1,230 feet in length. The season coincides with the nesting period of the marbeled murrelet, the most abundant breeding seabird in this area. In a two-year period during which seabird/gill net fishery interactions were monitored, 33 alcids were reported killed in gill nets. Most fishermen did not cooperate in the study, but indicated they caught birds every year. In addition to marbled murrelets, common murres and rhinoceros auklets also were reported taken. Almost all the marbeled murrelets taken were breeding birds, so the overall level of mortality (estimated at 175-250 birds based on total fishing effort) is more extensive because each bird killed in a gill net would mean the death of the nestling as well. Estimates indicate a 7.8% decrease in the potential population of the colony per year.

The river systems of the Gulf of Alaska support salmon fisheries of great economic importance to Alaska. Five species are harvested: sockeye, chinook, chum, pink and coho. Salmon are harvested with purse seines, and with drift and set gill nets. During the peak fishing season in 1983, 450 kilometers of gill nets were used. Incidental take depends not only on the species abundance but also upon the attitudes of the fishermen toward species regarded as pests and competitors. In the Copper River and Prince William Sound areas, 1,000 animals are estimated to have been taken in gill nets in the late 1970's. In addition to becoming entangled, animals are also shot or harassed with seal bombs. Harbor seals and sea lions are most commonly taken, and other marine mammal species include harbor porpoises, Dall's porpoises, sea otters, belugas, humpback whales and gray whales. Few fishermen apply for any exemption to take marine mammals under the permit system available, so information on the level of take is not systematically reported. In addition to marine mammals, seabirds are believed to be taken in gill nets throughout southeastern Alaska.

Sablefish, also known as blackcod, support a longline and trap fishery of increasing commercial importance. The major marine mammal/fishery interaction involves killer whales (orcas), which take fish from sablefish longlines. Fishermen, who view orcas as serious competitors, have recently begun shooting them and deterring them with explosives. Efforts are currently underway to improve deterrents.

Increasing economic importance of the walleye or "Alaska" pollock has led to increased effort in this trawl fishery in both the Bering Sea and Gulf of Alaska. Since 1980, when the first Korean-U.S. joint venture began, Japan, Poland and West Germany have also participated in joint efforts with U.S. catcher boats. The walleye pollock joint venture fishery in the Shelikof Straits incidentally captures and drowns hundreds of northern (Steller) sea lions each year. The number of sea lions incidentally captured by U.S. vessels has ranged from 958 to 1,436 in 1982 to 237 to 355 in 1984. The high level of mortality is attributed to the practice of leaving one end of the trawl net with the fish catch in the water for long periods of time prior to transfer from catcher boat to processor, during which time entrapped sea lions drown.

The Alaskan groundfish fisheries harvest a diverse assemblage of groundfish along with other species including mackerel, herring and sablefish. The domestic fisheries have been overshadowed by the fisheries of Japan, Poland, the Republic of Korea, and the U.S.S.R. However, joint venture fisheries between foreign countries and the U.S. have been increasing and are expected to eliminate all direct allocations to foreign fleets within a few years. Trawls are the major type of fishing gear, although longlines and gill nets are used for some species. Foreign vessels are permitted to take 580 marine mammals, and U.S. trawlers more than 1,000. Observers are stationed only on board the motherships of foreign fleets, making it difficult to determine actual levels of take. The vast majority of animals taken in the trawl nets are northern sea lions, although lost or discarded gear is suspected of being a major problem for some marine species.

Fisheries of Hawaii

The major species targeted by Hawaii's tuna fishery are yellowfin and bigeye tuna, with other species of lesser economic importance. The fishery has expanded in recent years in response to an increased demand in the U.S. for fresh tuna. The fishery takes tuna on longlines, handlines and trolls. Although no mortalities of marine wildlife have been directly attributed to the tuna fishery, both sea turtles and cetaceans are known to interact with commercial tuna fisheries in Hawaii. The level of incidental take has not been quantified, but reports indicate sea turtles have become entangled or actually hooked, and several species of cetaceans have been reported to take bait and damage gear or take fish caught on the longline. Some deterrents have been tried to keep porpoises away from fishing gear, but a successful method has not been found. There are reports that fishermen shoot at animals, or use other methods of keeping them away from nets. Little investigation of these fishery interactions has occurred recently, and further study is needed to determine their extent.

Members of the snapper-grouper-jack complex are the targets of Hawaii's hook and line bottom fishery. Some longlines and traps also are used to take fish around the Islands, with major bottomfishing areas in the Northwestern Hawaiian Islands. The critically endangered Hawaiian monk seal occurs in a limited area around the Northwestern Hawaiian Islands, and the expansion of the fishery into this area is problematic. The Marine Mammal Commission has expressed concern over the development of a mothership fishery. Current information indicates that Hawaiian monk seals do interact with the fishing boats, but mortality has not been documented because there are no observers in the fishery. Pacific bottlenose dolphins have been reported to take bait and fish from operations in both the main and Northwestern Hawaiian Islands, but this has not been documented either. Sea turtles may also be entangled as they swim by the gear, and the National Marine Fisheries Service has authorized an acceptable level of mortality incidental to fishing operations. Although fishermen are required to report any incidental taking in this fishery, there is no observer program and no reports have been received to date.

Other Pelagic Fisheries

The majority of tuna are harvested from the Pacific Ocean. The U.S. tuna fishery harvests four major species of tuna: yellowfin, skipjack, bluefin and albacore. The close association between yellowfin tuna and porpoises in the Eastern Tropical Pacific (ETP) is the basis for the tuna purse seine fishery. The large purse seine nets entrap both the porpoises and fish, and not all the porpoises can be released alive. Thirteen species of porpoises are taken incidentally in the tuna fishery, but spotted, common, striped, and spinner dolphins are taken most often. Although dolphin mortality has been drastically reduced since the 1970's, thousands of dolphins are taken each year by the U.S. fleet alone. Under the Marine Mammal Protection Act, the U.S. tuna industry is allowed to take 20,500 dolphins annually. In 1986, the porpoise mortality rate was unusually high, and the National Marine Fisheries Service issued emergency regulations to prevent the industry from exceeding its quota.

RECREATIONAL FISHERIES OF THE UNITED STATES

Approximately 17 million fishermen participated in marine recreational fisheries in the U.S. in 1985, and a majority of the fishing effort in all areas occurred within 3 miles of shore. Major species taken are flounder and bluefish in the Atlantic and mackerel in the Pacific. The traditional fishing pole with monofilament line was the most popular gear type. Monofilament line is responsible for the entanglement and death of several endangered species including brown pelicans, manatees, and several species of sea turtles.

ENTANGLEMENT OF WILDLIFE IN PLASTIC DEBRIS

In recent years, there has been increasing documentation of wildlife becoming entangled in lost and discarded fishing gear and other plastic debris. Plastics are persistent, strong and difficult to see, and are therefore a menace to many marine species, some of which are endangered. In addition, plastics may be ingested by many marine species.

Pinnipeds are particularly susceptible to entanglement, and at least six species have been reported entangled. It is believed that up to 30,00 northern fur seals die each year due to entanglement in fishing gear, primarily trawl netting. Sea turtles are frequently entangled in monofilament line, and in trawl and gill net fragments. Seabirds are reported to become entangled in derelict nets and in other debris such as plastic six-pack holders. Little information is available on the entanglement of seabirds because such incidents are not reported to existing stranding networks.

Many species of marine animals ingest plastic debris, mistaking it for food. Sea turtles evidently mistake plastic bags for jellyfish, and seabirds ingest small plastic pellets that resemble prey items. Four species of sea turtles and 50 species of seabirds are known to ingest plastic. Ingestion of plastic debris has also been reported for several species of dolphins and whales.

Entanglement may kill an animal outright or impair its ability to swim and feed. Ingested plastic debris may suffocate an animal, cause internal damage, or starve the animal by creating a false feeling of satiation.

CONCLUSION

Incidental take in active fisheries and entanglement in marine debris often reach staggering levels. For some populations, such as sea turtles, incidental taking is a major threat to survival. Although laws exist to manage fisheries to prevent or regulate incidental take, they are often difficult to enforce. Federal agencies with the authority to enforce these laws have tremendous discretion, and often choose not to prosecute illegal takes, particularly mass drownings of seabirds. While foreign fisheries operate in U.S. waters under permit, and with at least partial observer coverage, U.S. domestic fisheries operate largely without oversight.

The biggest challenge on the horizon is the eventual phasing out of foreign fishing operations in favor of U.S. commercial fishing ventures. With this changeover will come the elimination of the monitoring and data gathering on incidental take provided for in foreign fishing permits. Unless changes are made in the regulation of domestic fisheries, requiring observer coverage and information on incidental take, this source of direct observations will be lost.

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INTRODUCTION

Due to the uproar over the massive numbers of dolphins killed in tuna nets during the late 1960's and early 1970's, much of the American public is aware that marine animals die in the course of fishing operations. Few, however, are aware of how widespread an occurrence this is, and that for some seriously endangered species such encounters pose a major threat. Many government officials from coastal states have stated that "incidental taking" of marine animals in fisheries and entanglement in lost or discarded gear may be a serious problem, but there has been little research, especially at the state level, into this issue.

Data on the subject are scattered among researchers and institutions. Often, biologists and management agencies will focus on a particular fishery, or a particular population of animals. No one has attempted to fit these diverse pieces of information together. And while information for U.S. fisheries was difficult to obtain, Canadian fisheries information was even more elusive except for those cases where researchers have been involved in certain localized fisheries.

This report attempts to compile all available information on fisheries in which incidental taking of marine animals—cetaceans (whales and dolphins), pinnipeds (seals and sea lions), birds, and sea turtles--is known to occur. In some cases, the major interaction involves entanglement in lost or discarded fishing gear, and not in active fishing operations. Additional problems may result from the ingestion of plastic debris. A separate section in the report discusses the problems associated with debris and lost gear. The report also examines the character of the fishery itself--where it operates, how many vessels are involved, what type of gear is used.

Research on incidental taking in fisheries requires a basic understanding of many aspects of the fisheries themselves - the gear they use, the areas in which they operate, the number of fishermen involved, and more. Compiling this information is complicated by the fact that records are kept differently in each state, and many statistics are out of date. Defining a "fishery" in itself is not an easy task. In some instances a fishery may be defined on a very local geographic basis, such as in a particular river system; in others it may cover an entire oceanographic area. Some fishermen may fish for a variety of species, or use different gear depending on the season or area, and the statistics are not readily separable from records kept by fishery management agencies.

Because of these difficulties, it was easier to work backwards—to begin with reports of incidental take and then to determine which fishery was involved. For this reason, it is possible that incidental take problems exist in other fisheries not discussed in this report. The authors of this report welcome any additional information that might be available.

Another difficulty assessing the magnitude of incidental take lies in the sources of this information. For instance, many of the data were provided by the Smithsonian Institution's Marine Mammal Events Program (MMEP), which compiles data on the taking and stranding of cetaceans. Because of the political problems of reporting the illegal taking of a protected species (these problems are discussed in greater detail in the report), many of the animals are simply reported as "stranded." Thus, valuable information on entanglement is lost.

Information in the form of publications and communications also came from fishery management councils, federal and state agencies, marine mammal and sea turtle stranding networks and scientists. As many publications were consulted and some are not cited in the report, we have included all useful references at the end of each fishery section, so that the reader may have easier access to this information.

Although the data are necessarily incomplete, it is hoped that this synthesis will allow a larger picture to emerge. Are there problems for some species that are being overlooked? Are some types of gear especially troublesome? Are there problems that can be addressed through legislative or regulatory channels, through education, or other means? With the Marine Mammal Protection Act due to be reauthorized in 1988, some of these problems may be solved through amended legislation.

COMMERCIAL FISHERIES IN THE ATLANTIC OCEAN AND THE GULF OF MEXICO

Fisheries of the Northeast Atlantic

Newfoundland Inshore Fishery

TARGET SPECIES: Major species taken in Newfoundland's inshore fishery are cod, herring, salmon and a variety of groundfish species. Herring are primarily taken in April, salmon in mid-May to June, and cod in early June to October (Piatt et al. 1984).

GEAR: Large traps set near shore are commonly used for catching cod in Newfoundland. The basic design of a codtrap consists of a leader of webbing which runs from the shore or nearshore area to the mouth of a box-shaped net trap. The leader functions to divert fish swimming along shore into the trap. Codtraps are set on the ocean floor and may or may not have a bottom panel of netting. While the basic design of codtraps is similar, no two traps are alike since each fisherman will make modifications based on his personal experience and location. However, a typical codtrap may have a 210 foot leader of 5 inch stretch mesh and can extend some 60 feet in depth. The trap section may consist of 390 feet of 1.25 inch stretch mesh netting. Codtraps are set out early in the season and are taken up normally by the end of August. Fishermen typically tend codtraps two times every day.

Groundfish gill nets are set near or on the ocean bottom to catch cod and other demersal species. As with codtraps, however, no two are the same. Groundfish gill nets are constructed of panels of netting-standard size is 300 feet in length. A typical groundfish gill net is 330 feet in length and 10 feet in depth (Eastern Fishermen's Federation 1984). The number of panels set together may vary from one to many but according to Perkins and Beamish (1979) groundfish gill nets in Newfoundland are typically set in multiples. Cod gill nets used in Newfoundland are made of monofilament nylon net of 140 mm mesh. Groundfish gill nets are set further offshore than cod traps and are tended by fishermen every two to four days. Depths at which these nets are set range between 30 to 185 meters.

Salmon gill nets are set in midwater or positioned at the water's surface sometimes with one end fastened to shore. Nets usually start at 450 feet in length and 10 feet in depth. The mesh of salmon gill nets is nylon and ranges in size between 140-152 mm mesh. Salmon gill nets are set from 30 to 200 fathoms offshore. Depths at which midwater nets are set range betweeen 6 to 10 meters.

AREA OF OPERATION: The inshore fishery of Newfoundland is conducted during the summer months when capelin migrate to inshore areas. Capelin are schooling fish which inhabit arctic and subarctic seas in the Atlantic and

Pacific Oceans. On the east coast of North America, capelin occur from Hudson Bay to Nova Scotia, but are most abundant around Newfoundland and Labrador. Many commercial species of fish in Newfoundland feed on capelin including cod, salmon and a variety of groundfish species and therefore much of the inshore commercial fishing activity is influenced by capelin abundances (Carscadden 1984).

The relative distribution of capelin in coastal waters varies seasonally but generally peaks in Newfoundland in June and July when beach spawning occurs. Spawning usually begins in late May on the west and south coasts of Newfoundland and occurs progressively later further north toward Labrador where spawning may not occur until August in some years. Inshore spawning normally continues for 4 to 6 weeks. Once the larvae have hatched they drift into deeper waters to mature and feed in large concentrations before returning to shallow water to spawn at 3-5 years of age.

Capelin is also a major food source for whales, seals and seabirds in Newfoundland. Therefore, fish, marine mammals, sea birds and people all depend on a food chain in summer based on the abundance of capelin. Consequently, the complex marine wildlife/fishery interactions that have been documented for Newfoundland's inshore fishery are related, at least in part, to the abundance and location of capelin.

LEVEL OF EFFORT Newfoundland's inshore fishery consists of small open-boat fishermen who typically leave in the morning and return from fishing the same day. In terms of effort, in 1980 there were approximately 7,500 codtraps, 180,364 gill nets and 1,067,227 fathom salmon gill nets in operation in Newfoundland (Lien 1981).

INCIDENTAL TAKE/ENTANGLEMENT Historically, there has been an ongoing conflict in Newfoundland's inshore fishery involving whale collisions with fixed gear. Over the past few years, the majority of whale entanglements have been reported on the southeast coast of the island of Newfoundland but southern Labrador has been the area where whale problems have been most severe (Lien et al. 1984a). Major species involved in these incidents are baleen whales, primarily humpbacks (Lien et al. 1984b). In 1979, mortality of humpback whales peaked at 15 to 20 per year. This peak in mortality was attributed to several factors including: an increase in inshore fishing effort; the development of new, stronger synthetic fishing gear; and increased numbers of humpbacks in inshore waters due to a scarcity of immature capelin offshore. In addition, although the whale/fisherman conflict was not a new problem, fishermen's attitudes had changed resulting in an increase in reporting of incidents. Each of these factors played upon another. For instance, in earlier years when cotton and hemp fishing gear was used whale collisions produced some damage to fishing gear, but entrapments or noticeable damage to the animal was infrequent (Lien 1981). With the introduction of synthetic gear, entanglements appear to have become more severe for whales that are unable to break free of synthetic nets, and a greater economic loss for fishermen due to significant levels of gear damage. In 1979, the annual loss of fishing gear to inshore fishermen was 3 million dollars, which was about 3% of the total value of this Newfoundland fishery. In general, humpbacks are responsible for 70-90% of the inshore gear damage in Newfoundland and Labrador.

The first year that comprehensive data are available on whale entanglements in fishing gear in Newfoundland's inshore fishery is 1979 (Lien 1981). Between 1979 and 1985, 556 whales became entangled in fishing gear in Newfoundland's inshore fishery (Table 1). The majority of these incidents, 328 or approximately 59%, involved humpback whales. Of these, 246 (75%) were been released alive, 74 (23%) died and the status of the remaining humpbacks is unknown. Other whale entanglements over this period involved 85 minke whales, 12 finback whales and 141 "other." Species of whales classified by researchers as "other" have included pothead (pilot whale), beluga, narwhal and bottlenose whales.

The majority of whale entanglements involved codtraps and groundfish gill nets (Table 2). Codtraps have been the most frequent gear involved, with 179 cases or 51%. Lien (1981) noted that codtraps hit by whales are usually the ones producing the highest catch of cod. In 75% of the cases capelin were in the vicinity of the trap. In the majority of whale collisions the leader of the trap is involved. In addition, traps set in areas of poor water visibility were more likely to cause whale collisions as compared to those set in high visibility areas.

According to Lien (1981) entrapment of smaller cetaceans, primarily Atlantic white-sided dolphins and harbor porpoise, in Newfoundland's inshore fishery is very frequent but is not reported because gear damage caused by these animals is minimal and entrapped porpoises are often taken for food. In 1980, 100 fishermen surveyed in eastern Newfoundland reported catching 254 porpoise in gill nets (N=236) codtraps (N=6) and fathom salmon nets (N=12). From this it was estimated that the total number of porpoises taken in the eastern Newfoundland in 1980 was 5,111 animals (calculations were based on the number of gear units operating in the area in 1980 multiplied by catch per unit effort determined from the 100 sampled fishermen). The total number of porpoises taken in all of Newfoundland in 1980 was estimated to be 25,399. However, since the sample of fishermen reporting porpoise by-catch were concentrated in Eastern Newfoundland, the author indicated that this extrapolation to all inshore gear may not be valid. The types and number of porpoise species estimated to be taken was not specified in these calculations.

The inshore fishery also takes considerable numbers of harp seals. However, according to Lien et al. (1984a) only when fishermen become alarmed because of the large numbers of animals caught are these incidents reported. For instance, in 1984 three fishermen reported catching harp seals which included the following statements: "In 1 wk. fishermen caught over 200 (harp seals) in gill nets; up to 68/day", "20-30/day in groundfish gill nets" and "many" taken each day in groundfish gill nets" (Lien et al. 1984a). Consequently, it is believed that these reports reflect a considerable underestimate of actual numbers captured.

Leatherback sea turtles are also reported to be taken in the inshore fishery on occasion. In 1984, leatherback turtles (number unspecified) were reported taken in trawls and killed by fishermen (Lien et al. 1984a). In 1983, two reports of entangled leatherback sea turtles were received, both of which had been taken in gill nets and one of which died (Lien et al. 1983) and in 1982 reports of leatherback entanglements included one which was dead in a gill net and one which was released alive from a shark net (Lien et al. 1982).

In 1978, inshore fishermen from a large portion of the province signed a petition requesting the Government of Canada to lift the ban on whaling. Fishermen believed that the hunt would not only decrease whale numbers, thereby minimizing gear damages, but also put the "fear of man back" in the whales which were said to have lost this fear and were unafraid to approach humans and manmade equipment (Lien et al. 1984b).

In response to the growing concern among fishermen over gear losses, and that of environmentalists who feared increasing whale mortalities, a program was established in 1978 by the whale research group at Memorial Institute of Newfoundland, in cooperation with Fisheries and Oceans of Canada, to study and manage Newfoundland's inshore fishery. This is perhaps the only example within North American waters where an inshore fishery that is known to incidentally take marine mammals is receiving extensive attention and assistance to deal with the problem. In short this program shows how educational programs for fishermen and the general public have been essential in dealing with the whale problem (Lien et al. 1984b).

A primary step in establishing such a program was to educate fishermen as to the status of humpback and other whales and to encourage fishermen to free whales from their gear. Newfoundland's inshore fishery program monitors gear damage and whale mortality, conducts scientific studies, and provides services to fishermen to minimize gear loss and whale deaths. The program also offers assistance to fishermen to scare whales away, release entrapped whales and minimize economic losses by selling catches of basking sharks, another animal incidentally taken in this fishery.

Reports of whale entrapments are received from fishermen by phone on a toll-free number and through gear damage report cards (Lien et al. 1984a). Fisheries observers also report entanglements. For fishermen who report entanglements by phone, help is sent within 24 hours. In most cases the whale swims into a net and either gets tethered by the anchor lines, fouled in the netting or both (Perkins and Beamish 1979). When a collision occurs, 20 to 30% of the time the animal becomes caught in the gear (Lien et al. 1984b).

Although it is difficult at this time to determine whether the program has been effective, the general feeling is that it has (Lien et al. 1984b). Since 1979 when 40% of all entangled whales died, the percentage of entanglement-induced mortalities has decreased to 10%. This is a significant change from previous years when requests from fishermen for help from federal and provincial fisheries agencies, the Marine Sciences Laboratory, the university and others went unanswered while entangled whales lingered in nets for months slowly dying (Lien 1978).

What is clear is that a program such as Newfoundland's is essential in gathering pertinent information on fishery conflicts. Without such a program, which is the general case for U.S. domestic fisheries, information on entanglement is grossly incomplete and largely based on strandings "after the fact."

In southeast Newfoundland, the area of Witless Bay has the largest breeding concentration of seabirds in Canada (Brown and Nettleship 1984). This area harbors 2.2 million individuals including, in decreasing order of abundance, Leach's storm petrels, Atlantic puffins, common murres, black-legged kittiwakes, herring gulls and smaller numbers of thick-billed murres, razorbills, black guillemots, great black-backed gulls and northern fulmars. Of these species, approximately one half of the individuals feed almost entirely on fish, mostly capelin. During the major part of the breeding season from June to August, approximately 7300 tons of capelin are consumed by seabirds in Witless Bay.

Seabird bycatch of murres and puffins in the inshore fishery has been identified to be a problem in Newfoundland (Piatt et al. 1984). The majority of inshore net mortalities occur over a two-week period during the annual inshore spawning migration of capelin.

Historically, net mortality of murres was relatively low in the 1950's and 1960's but increased during the 1960's as the murre population grew and the gill net fishing effort increased in the colony area. By 1971, murre mortality in gill nets was estimated to be 30,000 breeding adults, or about 20% of the local breeding population. In 1972 about 20,000 adult murres or 13% of the breeding stock were drowned in gill nets.

Although net mortality decreased through the 1970's this is attributed to a decline in capelin stocks and therefore fewer birds were foraging in heavily netted areas (Piatt et al. 1984). In 1980-81 bycatch surveys in the Witless Bay area found that only 3 to 4% of the breeding stock was taken in nets. However, even these low mortality rates are cause for concern since adult murre mortality due to all possible causes should not exceed 6 to 12% per year to maintain a stable breeding colony. Adult Atlantic puffins are also taken in the inshore fishery but to a lesser degree. During three years of study adult Atlantic puffin net mortality remained lower than 1.6% of the breeding population.

The mortality of these alcids is especially significant since it occurs during the peak of the breeding season and the rearing of young by only one parent is almost impossible (Nettleship 1972).

Studies of this seabird fishery problem have found that most murres (83%) drown in bottom set cod gill nets which are set at depths of 30-185 meters, whereas relatively fewer are caught in surface set salmon gill nets (16%) or codtraps (.7%) (Piatt et al. 1984). In terms of the number of murres caught per net, cod gill nets averaged 11 murres per net. Salmon nets were only slightly lower with 8.9 murres per net.

Puffins, on the other hand, mostly drown in surface set salmon gill nets or codtraps (55%) as compared to cod nets (45%) (Piatt et al. 1984). The rate of take of puffins is also higher in surface set salmon nets (3.6/net) and codtraps (1.9/net) than in cod gill nets (0.8/net).

The difference in the type of nets responsible for murre and puffin mortality has been attributed to differences in feeding behavior of these species with murres feeding at greater depths than puffins (Piatt et al. 1984). Studies have also found that distribution of net mortality around the Witless Bay Seabird Sanctuary is concentrated within a 60-km foraging zone north and south of the colonies.

Contrary to most fisheries conflicts which are largely influenced by the level of fishing effort, mortalities of murres and puffins has decreased in recent years while fishing effort has increased. This is due to the fact that bird mortality is correlated with the presence of inshore spawning stocks of capelin. It is predicted that if capelin stocks return to the size of the early 1970's net mortality of these birds will increase dramatically (Piatt et al. 1984). A preliminary examination of the 1982 capelin spawnings and seabird bycatch data indicated that capelin were much more abundant inshore as compared to previous years and that murre bycatch had increased two to three fold over 1981.

There are five other major seabird colonies in Newfoundland but little is known of alcid net mortality in these areas. Anecdotal information, however, indicates that net mortality occurs wherever there are fisheries operating in areas of large seabird concentrations (Piatt et al. 1984).

Table 1. Incidental take/entanglement of whales in Newfoundland's inshore fishery, 1969-1984 (Lien 1981, Lien et al. 1984a).

Year	Minke			Humpback			Fin			Other Large Whales			
		Released			Released			Released			Released		
	Dead	Alive	?	Dead	Alive	?	Dead	Alive	?	Dead	Alive	?	TOTAL
1969	-	-	-	1	-	-	-	-	-	-	-	-	**1**
1970	-	-	-	-	-	-	-	-	-	-	-	-	**0**
1971	-	-	-	-	-	-	-	-	-	-	-	-	0
1972	-	-	-	-	1	-	-	-	-	-	-	-	**1**
1973	2	-	1	1	-	1	-	-	-	-	-	-	**5**
1974	2	-	1	1	-	1	-	-	-	-	-	-	**5**
1975	2	-	1	1	1	3	-	-	1	-	-	-	**9**
1976	3	-	-	1	2	1	-	-	-	-	-	-	**7**
1977	1	-	-	2	3	-	-	-	-	-	-	-	**6**
1978	2	-	-	6	3	2	-	-	-	1	-	-	**14**
1979	9	1	-	13	34	-	4	3	-	6	5	-	**75**
1980	9	3	-	17	44	-	1	2	-	4	11	-	**91**
1981	8	3		8	23		-	1		49	11		103
1982	5	4		4	31		-	-		15	14		**73**
1983	4	7		5	30		-	-		1	14		**61**
1984	6	2		6	20		-	-		4	6		**44**
1985	7	2		8	44		-	-		?	?		**61**
TOTAL	**60**	**22**	**3**	**74**	**246**	**8**	**5**	**6**	**1**	**80**	**61**		**556**

Table 2. Whale entanglements in Newfoundland's inshore fishery by gear type, 1979-1985.

		Codtrap	Gill net	Salmon net	Other
1979	Minke	4	3	1	1
	Humpback	21	26	1	2 squid traps
1980	Minke	4	3	3	2
	Humpback	22	18	5	5
	Finback	-	2	-	1
1981	Minke	6	2	3	-
	Humpback	10	14	5	2
1982	Minke	3	-	1	1 mackerel net
	Humpback	17	10	2	5
1983	Minke	8	2	1	-
	Humpback	24	4	7	-
1984	Minke	7	1	-	-
	Humpback	12	13	-	1 crab pot
1985	Minke	6	3	-	-
	Humpback	35	12	5	2 crab pots
TOTAL		179	113	34	22

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New Brunswick Herring Weir Fishery

TARGET SPECIES: Herring have supported a major inshore fishery from Maine to New Brunswick, Canada for over a century, primarily juvenile herring (ages 1 to 3 years old) for purposes of sardine canning. In Charlotte County, New Brunswick, the weir fishery for herring is of considerable economic importance to this region. Landing data shows increased catches of herring by fixed gear in New Brunswick from 20,448 metric tons (45 million pounds) in 1981 to 26,066 metric tons (57 million pounds) in 1982 (Fogarty and Clark 1983).

GEAR: A weir consists of a leader or pattern of poles set in a line from shore to a trap which is made of relatively small meshed netting and is set out in a configuration roughly resembling a heart. Fish swimming along shore are diverted by the leader from shore into the trap. Once inside, fish become disoriented and swim in circles. The size of weirs and type of netting is not standard in the herring fishery but varies among fishermen. To remove the fish, a purse seine is placed inside the weir. Fish caught in the seine are then transferred with a pump or dip net into a boat. Since fish can live for long periods of time in weirs they are often held for several days.

AREA OF OPERATION: Traditionally, fixed gear such as weirs, gill nets, and traps have been used in the herring fishery all along the coast of Bay of Fundy and Nova Scotia (Stobo et al 1982). Weirs are primarily used in the Bay of Fundy where severe tides do not allow for the use of other types of fish traps. The New Brunswick fishery peaks during the migration of spawning herring into northern locations in August and declines while herring move to more southern areas through October.

LEVEL OF EFFORT: In 1980 there were 216 licensed weirs in Charlotte County. Although landing values for this year were not available, the landed value of herring by weirs from 1974 to 1979 averaged 2.2 million dollars per year (Smith et al. 1983).

INCIDENTAL TAKE/ENTANGLEMENT: The herring weir fishery of New Brunswick entangles 70 harbor porpoise every year (Smith et al. 1983). This is based on an annual catch of harbor porpoise of 0.328 per weir for the 216 licensed fishermen in 1980. Of this number approximately 36% (N=27) die as a result of the entrapment. While this number represents an annual mortality of less than 1% of the total population of harbor porpoise, an additional unknown number of porpoises from this population are also taken in weirs in northern Maine, and a few scattered weirs along the Digby, Nova Scotia shore, and in Saint John County, New Brunswick.

Analyses of the interaction of harbor porpoises with the herring weir fishery have found that porpoises are trapped in weirs from May to December but the majority are taken in the summer which reflects the seasonal abundance of both harbor porpoises and herring.

Aging studies indicate that young porpoises are more frequently entangled in weirs, which has been suggested to be a consequence of inexperience of these animals in echolocation, navigation and prey capture. According to weir fishermen, harbor porpoises enter weirs at night thus suggesting that visual detection of these nets is important for avoidance.

Harbor porpoise may also enter weirs at night when following herring, which tend to swim closer to the surface at night, and thus are more susceptible to being caught in weirs.

Fishermen surveyed in 1980 (Smith et al. 1983) indicated that less than half of all porpoises caught are shot or die as a result of the entanglement; 72% of the fishermen interviewed stated that they attempt to release animals unharmed. Weir fishermen indicated that interactions with harbor porpoises were tolerated more than that of harbor seals which are considered a pest.

A groundfish gill net fishery also exists in New Brunswick, although little information was available. According to Smith et al. (1983) harbor porpoises are also taken in gill nets in New Brunswick but that overall mortalities attributed to gill net entanglements do not appear to be any greater than that of the weir fishery.

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New England Lobster Trap Fishery

TARGET SPECIES: The most commercially valuable species for the New England fishing industry is the American lobster. Preliminary landings indicate that 41.9 million pounds of lobster were taken in 1985 valued at $102 million which constitutes approximately 25% of the value of all species landings in New England and 91% of all lobster landings in the United States.

GEAR: Lobsters have been traditionally harvested with traps constructed of wood although plastic coated wire, plastic and aluminum traps have been used increasingly. Traps used in the offshore fishery are generally larger than those used inshore because of the greater deck space available on the larger vessels used in the offshore fishery, the longer soak time (time between trap hauls) and the greater availability of legal sized lobsters in offshore areas (Smolowitz 1978).

AREA OF OPERATION: The American lobster fishery is arbitrarily divided into two principal areas of harvest: the inshore fishery concentrated along the coastal areas from Maine to New Jersey out to depths of 40-100 meters; and the offshore fishery encompassing areas along the continental shelf and margin from Corsair Canyon to Cape Hatteras in depths of 100-600 meters (New England Fishery Management Council 1982). Historically, the major U.S. region of lobster harvest has been in New England. In 1985, 91% of the total U.S. lobster harvest was landed within the states of Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut. Landings in the State of Maine have generally accounted for the greatest portion of the New England catch.

The inshore fishery of New England is responsible for the greatest lobster production and revenue. The majority of landings in the inshore fishery come from traps set within the state territorial waters (0-3 miles from shore), although a portion of the inshore catch may come from coastal fishermen who devote a part of their time fishing from 3 to 15 miles off shore in the U.S. Fishery Conservation Zone (FCZ) (New England Fishery Management Council 1982, 1983). In recent years the inshore fishery has experienced record high levels of catch. During the period 1978-1982 New England landings taken within 3 miles of the coast increased steadily from approximately 26.9 to 33.7 million pounds. Landings subsequently peaked in 1983 at 37.2 million pounds and declined slightly in 1985 to 36.1 million pounds. These trends in production have been attributed to increased effort in the coastal trap fishery.

The increased demand for lobsters and the development of deep water trap haulers gave impetus to the offshore trap fishery during the 1960's. All lobsters taken in the offshore fishery come from areas within the FCZ. According to a National Marine Fisheries Service official in Woods Hole, Massachusetts (Fogarty pers. comm.), the primary area of concentration is along the edge of the continental shelf at submarine canyons, although the mid-water fishery spreads throughout the continental margin. Reported landings for the offshore trap fishery in recent years have ranged between 4 and 6 million pounds (New England Fishery Management Council 1982, 1983).

In the inshore fishery traps are set singly or, more commonly, in groups strung along a single line which reduces the handling time per trap. Single traps are attached to a line measuring 30 to 300 ft. in length which is attached to a toggle buoy. The toggle buoy is rigged to a second buoy by 15-30 ft. of line. Trawl lines may have anywhere from 5 to 15 traps attached to a main line which is buoyed at each end. One boat may fish anywhere from 200 to 1600 or more traps (Fogarty pers. comm.). In the offshore fishery traps are almost always fished in lines which may vary in length from 20-100 traps each, sometimes extending over 1.5 km on the ocean bottom (Smolowitz 1978).

The time between trap hauls, or soak time, can vary between 1 to 5 days in the inshore fishery depending on various factors including weather, season and the total number of traps being fished by an individual fisherman (Fogarty pers. comm.). On a seasonal basis, the catch per trap per day is generally three times higher during the months of August-November as compared to December-March (Hamlin and Ordway 1974). Consequently, traps are tended more frequently during the summer and fall. Although there are no seasonal restrictions for the U.S. lobster fishery, the major time of harvest in the inshore fishery is from June to November.

Soak time in the offshore fishery ranges between 5 to 10 days, with an average of one week although there is considerable variability in soak time relative to climatic and seasonal factors. During the winter, soak times are considerably longer (Fogarty pers. comm.). As in the inshore fishery, the offshore fishery operates year round with peak harvests in June through November.

The principal areas of lobster harvest varies for each of the New England states. The efforts of Maine and New Hampshire are primarily directed toward the inshore fishery. Massachusetts has both an inshore and an offshore fishery, whereas Rhode Island's fishery is primarily conducted offshore. The inshore fishery of Connecticut is concentrated within the Long Island Sound (New England Fishery Management Council 1982).

LEVEL OF EFFORT: The number of fishermen and vessels engaged in the lobster fishery of New England has been reported to have substantially increased in the past two decades, particularly for the inshore trap fishery (New England Fishery Management Council 1982). However, current information on these numbers are not presently available (U.S. Dep. Commerce 1985). It is estimated that there are approximately 10,000 boats operating in the coastal trap fishery (New England Fishery Management Council 1982). Since the lobster fishery is of a seasonal nature many fishermen work on a part-time basis, supplementing their income by participating in other fisheries during low seasons. In fact, those fishermen who participate in the lobster fishery on a part-time basis represent the majority, and contribute a major portion to the New England lobster harvest (New England Fishery Management Council 1982).

The best available measure of effort for the entire lobster fishery in New England is based on the number of traps involved in the fishery. In recent years there has been a considerable increase in the number of traps used. The most current official report of trap number is for 1980 when 2.4 million traps were used inshore with 25,000 traps in use offshore (Fogarty pers. comm.).

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INCIDENTAL TAKE/ENTANGLEMENT: In 1982, the New England Fishery Management Council addressed the possible effects a Fishery Management Plan for the American lobster fishery would have on marine mammals and endangered species occurring in the Northwest Atlantic Ocean. They concluded that the lobster fishery is unlikely to result in the incidental catch of endangered species.

However, since 1975 a total of 26 cetaceans have been reported entangled in lobster gear (Table 3). This number includes 20 cases involving whales that are listed as either threatened or endangered including finback, right, sperm, and humpback whales. The remaining incidents involved minke whales and a Risso's dolphin.

Eleven cases involved finback whales, nine of which occurred within the period of 1981-1984 in New York waters: four cases occurred in 1981 in an area southeast of Shinnecock Inlet, and five cases of entanglement were reported to have occurred off Montauk (two cases in 1982 and three cases in 1984). One of these finback whales reported by Sam Sadove of the Okeanos Ocean Research Foundation (pers. comm.) towed a total of 23 lobster pots for five days. The two additional finback entanglements were reported outside New York waters. One was found near the Isle Au Haut, Maine, in November 1975. Another was a sighting of finback whale in June of 1984 towing at least two lobster pots and well entangled in line 10 km offshore near Race Point buoy in Barnstable, Massachusetts.

Four entanglements in lobster gear involved right whales. One occurred in the vicinity of Long Beach, New Jersey, in August 1976. Another happened in 1983, one occurred in Boothbay, Maine in May 1985, and the remaining incident involved a whale reported with a line through its mouth and around its head on southern Stellwagen Bank. There is also one report of a sperm whale which was found dead in 1979 in the vicinity of Veatch Canyon entangled in lobster trap lines.

Kirt Horton of the Mystic Aquarium in Connecticut (pers. comm.) reported that in the last three years two humpback whales have also been reported entangled in lobster trap lines. One, a male of 22 ft. in length found off Watch Hill, New York, died because of entanglement in a trap line. The other, a female measuring 55 feet in length was successfully disentangled from a lobster pot with hedge clippers.

Most recently, a humpback whale was sighted in New England with a rope line wrapped around its body several times strapping its mouth shut but whether the line was part of a lobster pot is unknown as is the fate ot the whale.

The Smithsonian Institution has been collecting information through the Marine Mammal Events Program on the stranding of cetaceans and the possible related causes of these occurrences (Hare pers. comm.). Data for recent years include cetacean entanglement in lobster trap gear. One involved the release of 25 foot minke whale entangled in lobster gear 2.5 km east of Nahant, Massachusetts in late October, 1984. Another incident involved a smaller cetacean, a female Risso's dolphin, found dead off City Island, New York, in September, 1982, entangled in a lobster trap line in

85 feet of water. In addition, there have been three other reports of minke whales becoming entangled in trap lines off of Maine since 1978.

According to Philip Averill of the Maine Department of Marine Resources, an estimated two seal pups per port per year are captured in lobster traps set in mid-coastal areas of Maine (Gilbert and Wynne 1985). In addition, lobstermen in the area are becoming increasingly concerned with seal interference in lobster fishing activities. According to a report by the Maine Department of Marine Resources (Comm. Fish. News 1985) with the increase of the harbor and gray seal populations in Maine has come an influx of complaints from fishermen who report that seals are stealing bait, opening trap doors and eating undersized lobsters once they have been culled from a trap. In some areas the lobstermen are threatening to shoot the seals, although no documentation of such occurrences has been reported.

Recent surveys conducted by interview of lobster fishermen (Comm. Fish. News 1985) showed that the seal related problems were localized and occurred mostly in, but not restricted to, areas near seal haulout sites and in water generally less than 15 fathoms. While fishermen have devised their own methods of deterring seals (e.q. tying the trap door closed, reducing the size of the funnel head, running steel side to side across the center of the trap head and even placing sea urchins in the bottom of the bait bag) they are calling for action to be taken by state authorities.

Sea turtles also become entangled in lobster gear but the frequency of entanglement has not been documented and reported incidents consist mainly of anecdotal accounts. The Center for Coastal Studies in Provincetown, Massachusetts released three leatherback turtles from lobster gear in recent years (Mayo pers. comm.). According to the Director of the Wellfleet Bay Audubon Sanctuary in Massachusetts (Prescott pers. comm.) leatherback turtle entanglements in lobster gear are reported every year. In August 1986 two leatherback turtles were reported entangled in lobster gear (Bigford 1986). One animal died from the entanglement and the other was sighted off Provincetown, Massachusetts one mile away from lobster buoys and was thought to have escaped since the lobster buoys were found one mile away. Two reports of leatherback turtles entangled in lobster traps in New York were recorded in 1986 (Sadove pers. comm.). One occurred in August south of Montauk, Long Island, and the other in November south of Southampton. Both animals were severely decomposed.

Cormorants have also been reported to be found in lobster traps in Maine's inshore fishery (Comm. Fish. News 1985) although the frequency of such occurrences has not been documented. In addition, a biologist with the Marine Fisheries Office of the Connecticut Department of Environmental Protection (Blake pers. comm.) reported an instance of a dead osprey in a fisherman's lobster pot. Blake assumed the osprey entered the pot while diving in search of food.

Table 3. Records of incidental take/entanglement of endangered marine mammals and other species in the lobster trap fishery.

Date	Species	Location	Condition	Source
1975	finback whale	Isle Au Haut, ME	freed	T. McKenzie
1976	right whale	Long Beach, NJ	freed	SEAN v.1(10)
1979	sperm whale	Veatch Canyon	freed	S. Kraus
	minke whale	Cape Small, ME	dead	P. Mulhearn
	unidentified	Grand Manan Channel	dead	S. Katona
1981	finback whale	SE of Shinnecock Inlet, NY	freed	T. McKenzie
	finback whale	SE of Shinnecock Inlet, NY	freed	T. McKenzie
	finback whale	SE of Shinnecock Inlet, NY	freed	T. McKenzie
	finback whale	SE of Shinnecock Inlet, NY	freed	T. McKenzie
	minke whale	Vinalhaven, ME	alive	C. Reilly
	minke whale	1 mile south of large green island, ME	dead	P. Mulhearn
1982	finback whale	Montauk, NY	freed	T. McKenzie
	finback whale	Montauk, NY	freed	T. McKenzie
	Risso's dolphin	Harts Is, NY	dead	M. Hare
1983	right whale	?	?	T. McKenzie
1984	finback whale	Montauk, NY	freed	T. McKenzie
	finback whale	Montauk, NY	freed	T. McKenzie
	finback whale	Montauk, NY	freed	T. McKenzie
	finback whale	Race Point, MA	alive	M. Hare
	minke whale	Nahant, MA	alive/released	M. Hare
1985	right whale	Boothbay, ME	freed	M. Hare
?	humpback whale	Watch Hill, NY	dead	K. Horton
?	humpback whale	?	freed	K. Horton
1986	right whale	southern Stellwagen Bank	alive	CCS
	humpback whale	?	alive	CCS

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New England Groundfish Gill Net Fishery

TARGET SPECIES: The New England groundfish gill net fishery is highly variable in many respects thereby making it difficult to assess the overall characteristics of this fishery. For example, although at certain times and in specific areas gill netting efforts may be directed toward a particular species, the nature of a gill net is nonselective. Yet a major portion of gill net "by-catch" is marketable. Consequently, although the target species and those actually landed may not coincide, gill netting activities benefit from harvesting a diversity of species. In addition, there is a considerable amount of seasonal switching of effort between species or groups of species due to fluctuations in availability and abundance. The problem of attempting to define the species-specific fisheries in the New England region is discussed further in the New England Fishery Management Council's Fishery Mangement Plan for the Northeast Multi-Species Fishery (1985).

The most economically important groundfish species in New England waters are the Atlantic cod, haddock and yellowtail flounder (New England Fishery Management Council 1985). According to the New England Fishery Management Council (1985) the gill net fishery benefits most from the amounts of cod, hake, and pollock caught. In recent years the Atlantic cod and pollock fishery has become increasingly dependent on gill nets (Burns et al. 1983).

For individual state fisheries, gill nets may be of even greater importance, specifically in Maine and New Hampshire. In 1977, over 50% of the total landings of cod, white hake, and pollock were taken by gill netters in Maine. Similarly, gill net landings in the state of New Hampshire accounted for more than half of the cod, haddock, white hake, mackerel and pollock catch.

GEAR: Typically groundfish gill nets are constructed of monofilament net with a 6 to 6 and one half inch streched mesh. Pending implementation of the Fishery Management Plan for the New England Multi-Species Fishery all gill nets will be required to be of 5 1/2 inch streched mesh for purposes of stock management. At present, nets fished in the state waters of Maine and New Hampshire must be at least 5 1/2 inch stretched mesh, while Connecticut requires a minimum of 3 inches. There are no mesh requirements in the states of Rhode Island or Massachusetts.

Demersal gill nets are approximately 300 feet in length and 12 feet in depth and are commonly attached in "strings" of 10 to 12 nets each. Therefore, a continous string of gill net may extend 3,000 to 3,600 feet in total length. A common practice is to set multiple strings of gill net at one time, depending on a vessel's handling capacity with smaller inshore vessels setting fewer strings than larger vessels. Gilbert and Wynne (1985) observed boats which fished 3 or 4 strings while Carr et al. (1985) reported that a single vessel may set up to 6 strings of gill net. Consequently, a fisherman with 3 strings of gill net will fish a total of 6,000 to 10,800 feet of net while 6 strings may extend anywhere from 3 to 4 miles or more. In 1983, an average of 3.44 gill nets were used by each vessel operating in the New England gill net fishery (New England Fishery Management Council 1985). The average total length of all gill nets set by each vessel if strung end to end was estimated at 10,314 feet.

At present, there are restrictions pending that would prohibit a continuous gill net from exceeding 6,600 feet. However, there are no restrictions on the number of individual strings that a vessel may set. Moreover, although the length of an individual string may be restricted, there are no limitations on the distance between strings. The only state which regulates gill net length is Rhode Island where it is prohibited for a continuous net to exceed 600 feet in total length when set within one-half mile from shore.

Once a gill net has been set it is generally left unattended. The amount of time between net hauls varies depending on season, the number of nets being fished by an individual fisherman, and other factors. Only nets set within one-half mile from the Rhode Island coast are required by state law to be hauled once every 24 hours. Generally nets are tended daily although Gilbert and Wynne (1985) observed that 80 of the 601 nets that they sampled were set for two or more days. Gear tending has been a controversial issue between gill netters and other commercial and recreational fishermen who claim that untended, poorly marked gill nets often interfere with other fishing activities or become lost. The New England Fishery Management Council plans to enforce gear marking requirements via the multi-species Fishery Management Plan to alleviate gear conflicts. However, the Council decided that gear tending regulations would be inappropriate based on the claims of gill netters that if they were required to carry their gear on-board, any available space for catch would be so limited that they would be unable to operate at a profit.

AREA OF OPERATION: Generally, the gill net season extends through November. The areas in which gill net fishermen operate in New England are as unspecified as the fishery itself. According to Kate Wynne (pers. comm.) who is working on a project to determine the harbor seal interactions with commercial gill netters in New England, the areas commonly used by gill net fishermen are the same as those used by other commercial groundfish operations. Some fishermen use gill nets in depths up to 600 feet. The areas that have been identified as major areas for specific groundfish species by the New England Fishery Management Council (1985) include: a) inshore Gulf of Maine in water depths of up to 360 feet where major species are cod, pollock, American plaice, and haddock primarily during the months of April-July; b) deep water Gulf of Maine extending to the northern periphery in depths of 360-900 feet where the major species are redfish, whiting, haddock, cod and pollock and the fishery is conducted throughout the year; c) northeast peak of Georges Bank along the periphery of Georges Bank in depths up to 900 feet the where the major species are cod, haddock, winter flounder, yellowtail flounder, winter and pollock which are primarily landed in April-October and; d) central Georges Bank/southern New England in water depths of 600 feet or less and extending seasonally into the western Gulf of Maine and southern New England waters where the major species are cod, yellowtail flounder, winter flounder and haddock.

Much of the conflict between New England gill netters and other fishermen is caused by competition for productive fishing grounds. While gill net fishermen are being forced to fish in concentrated areas to avoid losing nets snagged by the ever-expanding dragger fleet, such areas of concentration are often highly productive and accessible to charter boats and private vessels. Consequently, the methods of drift fishing and jigging commonly used by these other fishermen often results in gear conflicts with gill netters (Carr et al. 1985).

LEVEL OF EFFORT: The numbers of permitted gill net tonnage vessels operating in the New England region in 1982 and 1983 were 169 and 129 respectively. This number does not include those vessels which were classified as undertonnage, being less than 5 tons. In 1983 there were an estimated 137 undertonnage vessels also operating gill nets (New England Fishery Management Council 1985). The most current official information available pertaining to the number of vessels, fishermen and gear operating in each of the New England states is for 1977. At this time there were 211 tonnage and undertonnage gill net vessels in operation in New England. Curiously, the National Marine Fisheries Service reported 211 "gear", or one per vessel, although most fishermen typically use more than one net. Massachusetts and Maine had the greatest number of vessels with 97 and 87 respectively. Accordingly, these states also had the most fishermen with 217 full and part-time fishermen in Massachusetts and 210 in Maine. New Hampshire had 25 gill net vessels and 61 fishermen while Rhode Island had considerably fewer vessels (two) and fishermen (three). More recent information for Rhode Island reported that there are now four or five gill netters operating out of Point Judith, Rhode Island alone (New England Fishery Management Council 1985). The majority of gill net fishermen in Connecticut fished for shad which are small herring-like fish and are caught in nets unlike the gill nets described above.

INCIDENTAL TAKE/ENTANGLEMENT: Conflicts between marine mammals and commercial groundfish gill netters are known to occur within the New England region. According to the New England Fishery Management Council's Multi-Species Fishery Management Plan (1985) the non-endangered marine mammals most likely to be taken incidentally in commercial groundfish gill net operations are the harbor porpoise, Atlantic white-sided dolphin, pilot whale, and harbor seal. In February 1984 the New England Groundfish Gillnetters were issued a five year Letter of Exemption (see section on legislation for description) to take or incidentally capture up to 180 harbor porpoises and 60 harbor seals per year during groundfish gill netting operations.

In August 1984 the Letter of Exemption was modified to allow the additional annual take of a total of 50 marine mammals of the following species: gray seal, white-sided dolphin, common dolphin, white-beaked dolphin and pilot whale. Although the taking of species other than harbor porpoise and harbor seals is infrequent, the purpose of the modification was to allow fishermen to report the take of any non-depleted species in the area. According to Wynne (pers. comm.) this additional information is valuable and should be reported.

Under the provisions of this Letter of Exemption the Division of Wildlife at the University of Maine (UMO) at Orono, Maine was designated as the recipient of reports from fishermen of incidental takes of the species included in the Letter. In the first-year summary of activities of this exemption process for 1984 (Gilbert and Wynne 1985) it was reported that permits and log books had been distributed to eleven gill netters to facilitate the reporting of incidental takes. Subsequently, these eleven gill netters reported the capture of 30 harbor porpoises, 5 harbor seals and 4 gray seals taken incidentally in gill nets in 1984.

As part of the research activities being conducted by UMO personnel under this exemption, at-sea samples are obtained to analyze the nature of marine mammal interactions with groundfish gill netters. During 1984, researchers were able to sample four gill net vessels between June 14th and September 19th, and to observe the retrieval of 31 strings of gill net or 601 nets. The boats sampled fished three or four strings of gill net, each string measuring 12 feet in depth and up to 6,000 feet in length. (Although the majority of these nets observed were tended daily, 60 of the observed nets (10%) were set for two nights and 20 (3.3%) had been set over three nights). During these at-sea observations five of the 31 nets had captured a total of six marine mammals: four harbor porpoises and two gray seals. All of these animals were entangled in separate 300-foot sections of the gill net strings. In one case, two harbor porpoises were entangled in opposite ends of the same gill net string. All of these animals were found dead.

The characteristics of the strings involved in marine mammal takes were not obviously different from those strings which did not capture marine mammals. All of the observed nets, both with and without cases of entanglement, were between 4,500 and 6,900 feet in length and were set within 40-77 fathoms (240-442 feet) of water. The nets were set for one to three days and the major species caught were cod, flatfish, dogfish, red hake and immature pollock.

During at-sea observations Wynne (pers. comm.) also observed a minke whale in June which surfaced repeatedly within 3 meters of a net which was being hauled. This whale circled the boat and swam parallel to the net without becoming entangled while it was apparently feeding on small crustaceans purged by the fish caught in the net.

The New England Fishery Management Council (1985) reported that the endangered species most likely to be taken incidentally to commercial groundfishing operations using a variety of gear types are the humpback, finback and right whales. During the past decade, 12 humpback whales, 5 right whales, and 2 finback whales that have been reported entangled in gill nets in the New England region (Table 4). Ten of these whales either died as a result of the entanglement or have an unknown status. Nine cases occurred in the areas of Jeffrey's Ledge or Stellwagen Bank which are areas of relatively heavy gill netting activity.

One whale, a female humpback estimated to be 38 to 40 feet long, was sighted entangled in a gill net on October 6, 1984. From photographs it was determined that the whale was entangled in lead line and net, the line going through its mouth, passing over the back, crossing and hanging vertically (Mayo 1984). The entangling gear was judged to be a monofilament groundfish gill net of 5 1/4 inch stretched mesh, with a heavy lead line, no bouys and a lightly floated top rope. One month after the initial sighting attempts to release the whale from the gill net were successful.

Nineteen additional cases of cetaceans entangled in gill nets have occurred over the past decade (Table 4). Seven involved minke whales, five of which died as a result of the entanglement. Ten incidents involved harbor porpoises and the other two animals reported were unidentified whales.

There has been no documentation of sea turtle entanglement in gill nets in the New England region. However, a worldwide compilation by Balazs (1985) of cases of sea turtle entanglement reported approximately 11% of the 55 cases investigated involved monofilament net. While no cases were reported from New England that specified a gill-net related incident it is likely that some sea turtle interaction with gill nets may occur in this region especially for loggerheads, leatherbacks and Kemp's ridleys. For example, in August 1986 a leatherback turtle was reported in Rhode Island with a cut on its flipper from twine entanglement but the gear involved was not identifiable (Bigford 1986). Another was found in September 1986 at Sandy Neck Beach, Massachusetts with one severed flipper and chafing marks around the other flipper and along its carapace indicative of a probable entanglement (Bigford 1986). In addition, Prescott (pers. comm.) of the Wellfleet Bay Audubon Sanctuary in Massachusetts reported anecdotal information on the incidental catches of gannets, fulmars and sooty shearwaters in New England gill nets.

In 1984 eleven fishermen received permits under this Letter of Exemption, which represent approximately 10% of the total number of groundfish gill netters fishing in the states of Maine, New Hampshire and Massachusetts in 1984. However, Wynne (pers. comm.) believes that any extrapolation of the results reported in this annual summary of incidental take of marine mammals would not be appropriate since research efforts were primarily directed toward those fishermen who, due to the location of their preferred fishing grounds, were most likely to incidentally capture marine mammals.

Table 4. Incidental take/entanglement of marine mammals in the New England groundfish gill net fishery.

Date	Species	Location	Condition	Remarks	Source
7/76	humpback whale	Jeffrey's Ledge	broke free	gill net	T. McKenzie
7/31/76	minke whale	Compton, RI	dead	caught in net	SEAN v.1(10)
8/25/76	minke whale	Provincetown MA	dead	wrapped in net	SEAN v.1(11)
8/31/76	right whale	off Wellfleet MA	alive	netting and line	T. McKenzie
6/4/77	unidentified whale	off Boston	dead	entangled in net	SEAN
10/77	minke whale	Jeffrey's Ledge	dead	gill net	S. Kraus
5/23/78	minke whale	Bailey's Is. ME	alive	gill net	S. Katona
6/78	right whale	Sesuit, ME	?	gill net	T. McKenzie
6/78	harbor porpoise full term fetus	-	dead	gill net	T. McKenzie
6/16/78	right whale	Cape Cod Bay	alive	30-35' length seen swimming	S. Katona
6/24/78	humpback whale	Jeffrey's Ledge	dead	gill net	T. McKenzie
6/27/78	unidentified whale (24 feet)	43%32'N 68%07'W	dead	gill net	S. Katona
11/78	harbor porpoise	-	dead	gill net	T. McKenzie
9/10/79	humpback whale	Jeffrey's Ledge	dead	gill net	T. McKenzie
?7/79	humpback whale	Jeffrey's Ledge	dead	gill net	T. McKenzie
7/12/81	humpback whale	Jeffrey's Ledge	dead	dragged up in gill net; Capt. said 2nd this year	T. McKenzie
8/9/81	humpback whale	Jeffrey's Ledge	?	gill net	T. McKenzie

Table 4. (cont.) Incidental take/entanglement of marine mammals in the New England groundfish gill net fishery.

Date	Species	Location	Condition	Remarks	Source
1981	humpback whale	?	?	gill net	T. McKenzie
1981	minke whale	?	?	gill net	T. McKenzie
9/16/81	harbor porpoise	-	dead	net	T. McKenzie
10/5/81	harbor porpoise	-	dead	gill net	T. McKenzie
10/18/81	harbor porpoise	-	dead	gill net	T. McKenzie
10/23/81	harbor porpoise	-	dead	gill net	T. McKenzie
3/29/82	harbor porpoise	-	alive	gill net	T. McKenzie
7/20/82	harbor porpoise	-	dead	gill net	T. McKenzie
10/16/82	harbor porpoise	-	dead	gill net	T. McKenzie
11/6/82	humpback whale	Truro, MA	alive	stranded alive in gill net; emaciated	M. Hare
5/15/83	right whale	off Plymouth MA	freed itself	gill net	M. Hare
9/6/84	right whale	Maine	freed itself	gill net	M. Hare
8/26/84	cetacean sp. (harbor porpoise?)	Cape Ann MA	alive	gill net	M. Hare
10/84	humpback whale "Efta"	N&S Stellwagen Bank	alive(?)	gill net	M. Hare
11/84	humpback whale "Ibis"	Massachusetts Bay	freed	gill net	T. McKenzie
1985	humpback whale	?	?	gill net	T. McKenzie
3/28/85	finback whale "Fern"	Stellwagen Bank	alive	emaciated in gill net	CCS
5/15/85	finback whale	Plymouth, MA	alive	gill net	M. Hare
8/7/85	minke whale	Acoaxet, MA	dead	net	M. Hare
10/12/85	minke whale	Cundy's Harbor, ME	alive	gill net	M. Hare
1986	humpback whale	Stellwagen Bank	?	gill net	T. McKenzie

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New England Otter Trawl Fishery

TARGET SPECIES: Otter trawls are the most important groundfish gear type used in New England in terms of production. In recent years, otter trawls have generally accounted for all flounder landings, 95% of haddock, whiting, and redfish, as well as approximately 85% of all cod landings in New England.

GEAR: Trawl nets used in this fishery are conical or bag-shaped nets towed behind a vessel to catch fish.

AREA OF OPERATION: The New England otter trawl fleet operates in both inshore and offshore areas of the Gulf of Maine and Georges Bank year round. Characteristically, the trawl fishery follows the migration of major groundfish species (i.e. cod, haddock, red hake, whiting and pollock) from principal inshore areas of concentration in summer to areas further offshore in winter. The major areas of fishing activity used by the otter trawl fleet includes those described for the groundfish gill netters of New England, in addition to areas at greater depths which are equally accessible.

LEVEL OF EFFORT: New England's otter trawl fleet has increased significantly in recent years. According to the New England Fishery Management Council (1985), the number of otter trawl vessels operating in the New England region has increased by 10% per year since 1970. During the period 1978-1984, the number of vessels weighing 5 gross tons or more operating only trawl gear in New England increased from 643 to 994. Consequently, the number of fishermen engaged in the otter trawl fishery has increased by more than 50%, with 2,703 fishermen in 1978 and 4,517 in 1984 (U.S. Dept. Commerce 1985). However, with the present increasing trend in participation in the otter trawl fishery there has been a decrease in landings and revenue per vessel since 1978.

The majority of fishermen and otter trawl vessels engaged in this fishery are from the state of Massachusetts. According to the New England Fishery Management Council (1985), in 1984 there were 3,197 fishermen and 638 vesels over 5 tons rigged with otter trawls in Massachusetts. Rhode Island had the second greatest number of fishermen (930) and otter trawl vessels (202), whereas Maine had fewer fishermen (803) but slightly more otter trawl vessels (229) than Rhode Island.

INCIDENTAL TAKE/ENTANGLEMENT: Since 1982 there have been three reported cases of cetaceans taken incidentally in otter trawls in New England and surrounding areas (Hare pers. comm). One incident involved a harbor porpoise which was killed 20 miles east of Barnstable, Massachusetts on December 8, 1982. Another incident occurred more recently in May 1986 involving a humpback whale which was hauled in alive in a bottom otter trawl on Jeffrey's Ledge. The whale subsequently died. In addition to these events there was a report recorded south of the New England region in New York in 1983 of a male common dolphin which was taken alive by a 55-foot flounder trawler off Shinnecock Inlet.

According to the New England Fishery Management Council (1985) in late autumn of 1978, seven Kemp's ridley turtles were found stranded along the coast of Cape Cod Bay, several of which were reported as cut and bleeding. The Council reported that the turtles may have been injured by entanglement in trawl nets or by contact with a vessel's propeller. However, the Council declared that there was no "solid evidence to indicate that fishing operations were responsible for the kills." Furthermore, the Council concluded that "based on inquiries to fishermen ... regular and numerous killings of Kemp's ridley turtles in Cape Cod Bay do not occur as a result of normal commercial fishing operations." It should be noted, however, that the total nesting population of Kemp's ridley turtles is estimated to be less than 500. More recently, in 1986 three reports of loggerhead turtles incidentally taken in trawl nets were documented in New York waters (Sadove pers. comm.). Two incidents occurred south of Sheepshead Bay, Brooklyn, and the other was reported one mile off Mattituck Inlet in Long Island Sound.

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New England Tub Trawl Longline Fishery

TARGET SPECIES: Automated longlining vessels and tub trawls are also used in New England to fish for groundfish species. Major species caught by longlines in 1977 were cod, cusk, haddock, white hake, halibut and pollock. Longlines are especially important for catching cod (New England Fishery Management Council 1985).

In 1977, 10.7 million pounds valued at $4.7 million was taken by longline gear in New England (not including the landings and revenue generated by the catch of pelagics such as swordfish, bluefin tuna and squid (and tilefish). Massachusetts derived the greatest production from longline gear with 8.7 million pounds valued at $3.8 million. Maine was second in revenue generated by longliners with 1.5 million pounds valued at $638,000. New Hampshire and Rhode Island landed 22 and 256 thousand pounds by longline valued at $149,000 and $169,000 respectively. Connecticut did not have major longline fisheries at this time.

In recent years the overall importance of longline gear to the groundfish fishery in New England has decreased. In 1977, 4.4% of all Atlantic cod landings in New England were taken by longline gear, only 1% was landed by this gear type in 1982. Similarly, while 6.1% of all red and white hake landings were taken by longline in 1977, this percentage has decreased to 1% in 1982. Additionally, landings of other important groundfish such as haddock, flounder, whiting, pollock and ocean perch have indicated decreased longline fishery contributions.

GEAR: A typical longline consists of a long central line to which smaller lines are attached at regular intervals spaced about every few feet. To these smaller lines, termed gangings or snoods, a large hook is attached. When a longline is fished each hook is baited and the line is put into the water anchored at each end. A line with a buoy is also attached to each end of the longline to mark its position on the surface of the water. The term "tub trawl" comes from a description of the galvanized tub which holds the longline. Longlines remain in the water for some time and are subsequently retrieved at one end, the anchor is removed and the longline is pulled in on a revolving lock or gurdy. As the line is brought onto the boat the fish are removed and the line is coiled into the tub and rebaited for another set (Nickerson 1978). Typically, New England longlines are set to fish overnight (Gilbert and Wynne 1985).

LEVEL OF EFFORT: The most current official record of the number of fishermen and vessels operating longlines in New England is for 1977. At this time 621 fishermen, 46 vessels and 199 undertonnage motor boats were in operation in the longline fishery. However, this number also includes those longlines employed in the fisheries for pelagics such as swordfish and tuna. A total of 243 longline gear were in use in 1977. Massachusetts had the largest number of fishermen, vessels and longline gear, followed by Maine. Rhode Island had considerably fewer fishermen and vessels engaged in this fishery, whereas New Hampshire's 11 fishermen all worked out of small motor boats with five longlines in use.

In recent years the New England Fishery Mangement Council (1985) reported 48 vessels in 1982, and 33 vessels in 1983 which were permitted to use longline gear in New England. However, the Council also reported knowledge of four automated longline vessels presently under construction or conversion. Three of these vessels were being constructed for the Maine-based Sea Bank Industries and the fourth belongs to High Seas Corporation of Massachusetts. Three of these vessels are 76 feet in length and the other is 147 feet. These automated longliners may set a possible maximum of 35,000 hooks each, which would be distributed over a maximum of ten sets of varying length. The smaller vessels mentioned previously may operate at some time of the year using tub trawls from various New England ports and would employ a maximum of six to eight sets at any given time.

INCIDENTAL TAKE/ENTANGLEMENT: There are three known cases of entanglement of endangered and threatened species in longline gear (Hare pers. comm.). Two involved humpback whales one of which was freed from a longline in Massachusetts Bay in 1984. More recently, a male humpback measuring 40-45 feet in length was sighted entangled in a cod longline on July 7, 1985. The whale, known as "Digit" (named for a finger-like marking), was sighted 4 miles from Provincetown, Massachusetts toward Stellwagen Bank. The 200-300 feet of longline that was wrapped around the whale's mouth, flipper and tail was presumed to have come from a fishing boat out of Provincetown. On July 30, researchers from the Center for Coastal Studies in Provincetown successfully removed about 85 feet of line from the whale. Two weeks later Digit was resighted free of all longline, suggesting that the initial removal enabled the whale to free itself. In addition, a leatherback turtle was killed with longline gear in Rhode Island in 1982 (Bigford 1986).

According to Gilbert and Wynne (1985) one tub trawler in Maine reported taking one or two seals per year that were hooked through the skin and captured alive. This fisherman reported that the seals were never hooked through the mouth, thus suggesting that the seals are snagged while following baited hooks. These investigators have received additional, but infrequent, reports of seals robbing bait off longlines and being hauled in if they swallow the hook. According to Wynne (pers. comm.) tub trawlers in New England incidentally capture very few animals each year most of which are harbor seals. Wynne is currently working on obtaining a Small Take Letter of Exemption to enable these fishermen to take harbor seals legally, and to provide a mechanism for monitoring the take of marine mammals in this fishery.

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Wynne, Kate, University of Maine, Orono, ME.

New England Atlantic Herring Fishery

TARGET SPECIES: The Atlantic herring fishery has extended from areas of Maine to New Brunswick, Canada for over a century and has targeted juvenile herring (ages 1 to 3 years old) for purposes of sardine canning. More recently, large scale fisheries for adult herring have developed on the western Gulf of Maine, on Georges Bank, and on the Scotian Shelf. Because of the collapse of the Georges Bank stock during 1976-1977, fishing efforts in recent years have been primarily concentrated in the Gulf of Maine. These herring migrate during autumn from feeding grounds along Maine's coast to southern areas of New England and the mid-Atlantic in winter. The fishery follows the migration of spawning herring from northern locations in August to more southern areas through October. Major spawning areas are located on Jeffrey's Ledge and Nantucket Shoals (U.S. Dept. Commerce 1985).

Commercial landings of Atlantic herring in the New England region for 1985 was 57 million pounds valued at $2.9 million. The state of Maine generally has the highest level of herring production. In 1985, 32 million pounds valued at $1.9 million was landed in Maine. Massachusetts was second in production with 24.5 million pounds landed in 1985 valued at $1 million. Landings in the states of New Hampshire and Rhode Island were comparatively less, while herring is not caught in significant commercial quantities in Connecticut. Although herring stocks in coastal areas have declined in recent years, export markets have stimulated fishing effort.

GEAR: Three principal gear types used in the herring fishery are purse seines, stop seines and weirs. Purse seines are primarily used by offshore vessels. Stop seines, which are seines set to close off a cove in which herring have schooled, and weirs, which are hung on stakes in a labyrinth pattern, are fixed gear used in coastal areas. Fixed gear such as weirs and seines have accounted for more than half of the New England herring landings in recent years (U.S. Dept. Commer. 1986).

AREA OF OPERATION: The coastal Maine fishery is primarily conducted with stop seines and weirs that concentrate on juvenile herring (Kelly and Mooring 1986). In 1985, 30.1 million pounds or 94% of Maine landings were taken within 3 miles of shore. Landings in the other New England states are taken primarily from the FCZ and concentrate on adult herring stocks.

LEVEL OF EFFORT: The most current official data on the number of fishermen and vessels operating in the herring fishery in New England are for 1977. At that time, 162 fishermen were engaged in this fishery with 20 vessels and 61 smaller craft in operation. A total of 30 purse seines, 54 stop seines and 31 weirs were being used in this fishery. Maine accounted for the greatest portion of fishing activity having the greatest number of fishermen, vessels and gear in the New England region. More current information reports that 10 or 12 herring boats of 25-50 feet in length presently use purse seines out of the port of Rockland, Maine, which are owned by the sardine plant there (New England Fishery Management Council 1985). Only eight fishermen using two purse seines and motor boats and four weirs were reported in New Hampshire. Massachusetts had eight purse seines operated by eight vessels and no fixed gear fishermen.

Rhode Island had three purse seiners but reportedly caught all herring with otter trawls and floating traps. Connecticut's contribution to the herring fishery in 1977 was minimal and was obtained by gill nets.

INCIDENTAL TAKE/ENTANGLEMENT: Researchers at the University of Maine, Orono had planned to investigate any conflicts that may exist between fixed herring fisheries and marine mammals in mid-coastal Maine in 1984 (Gilbert and Wynne 1985). However, the herring remained too far offshore in 1984 which was a disadvantage for both researchers and fishermen.

A preliminary account of incidental take/entanglement of endangered and threatened species listed one case of right whale entanglement in a weir (McKenzie pers. comm.). This incident involved a right whale cow and calf which became entangled but were freed from a weir in Grand Manan in August, 1976. Another incident of a humpback whale was reported from Lubec, Maine in September, 1979.

Sea turtles also become entangled in weirs. In August 1986, a Kemp's ridley turtle was found floating dead in a fish weir south of Hardings Beach, Massachusetts (Bigford 1986).

Purse seiners reportedly entrap seals and dolphins off mid-coastal Maine (Gilbert and Wynne, 1985). Occasional drownings of seals in purse seines have been reported. One fisherman reported he had captured two seals in one week in September but managed to release the seals alive. Wynne (pers. comm.) who plans to investigate the harbor seal/ herring fisheries interactions in New England claims that herring purse seiners take a very small number of marine mammals each year, the majority of which are harbor seals. From her current knowledge of this fishery, Wynne, estimates that herring purse seiners take ten harbor seals annually. Wynne, who was a primary influence in obtaining the Small Take Letter of Exemption for the New England groundfish gill net fishery, is presently working on developing a Letter of Exemption for the herring purse seiners for the purpose of gathering essential biological information on the harbor seal population from the animals taken in this fishery.

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Wynne, Kate, University of Maine, Orono, ME.

Squid and Mackerel Fisheries

TARGET SPECIES: Squid and Atlantic mackerel are targeted by both domestic and foreign fisheries that operate in U.S. waters off the northeastern United States. Joint venture operations for squid and Atlantic mackerel are also conducted in these fisheries involving foreign vessels in the U.S. Fishery Conservation Zone (FCZ) that take fish caught by U.S. vessels. However, this does not preclude foreign vessels from fishing independently within U.S. waters.

The species of squid that are commercially exploited along the northwest Atlantic continental shelf of the United States and Canada are the common or long-finned squid and the short-finned squid. Long-finned squid are preferred over short-finned because of better taste and texture qualities and bring two to three times the price of short-finned squid on the foreign market (Kolator and Long 1979).

The U.S. Atlantic mackerel fishery has landed approximately 6.5 million pounds of mackerel each year during the period of 1980 to 1985. In 1985, mackerel landings brought $1 million to this fishery. An additional 8.4 million pounds of mackerel valued at $584,000 was taken in joint venture mackerel fisheries by U.S. flag vessels. Massachusetts and New Jersey have consistently had the greatest annual mackerel landings.

Traditionally, the U.S. Atlantic squid fishery was a small enterprise conducted inshore with no offshore effort until the late 1970's primarily due to the general lack of demand in the domestic market (Kolator and Long 1979). However, with the development of a strong export market in the early 1980's the U.S. fishery has increased. During the period of 1980 to 1985 the Atlantic domestic catch rose from approximately 9.2 million pounds valued at $3 million in 1980, to a record high of 33.5 million pounds valued at $10 million in 1983 and then declined slightly to 26.6 million pounds valued at $7.3 million in 1985. The amount of squid taken in recent joint venture fisheries by U.S. vessels has ranged between 23.5 million pounds valued at $3.5 million in 1983 to 7.9 million pounds valued at $1.2 million in 1985 (U.S. Dept. Commerce 1986). Massachusetts, Rhode Island and New York have been the leading states in terms of U.S. squid production.

Foreign fisheries operating off the northeastern U.S. take a far greater amount of mackerel compared to domestic fisheries. Foreign vessels took 58.2 million pounds in 1985. Foreign fisheries have also dominated the squid fishery in terms of effort and catch in the northeast Atlantic. During the late 1970's the foreign fleet took an average of 110 million pounds of squid per year (Kolator and Long 1979). In recent years the total foreign catch has declined from 76.4 million pounds in 1982 to 16.7 million pounds in 1985.

GEAR: The principal type of fishing gear used in these fisheries is trawl gear. The size of nets used by the foreign trawl fisheries varies between countries and is presently being investigated by the National Marine Fisheries Service in Massachusetts (Waring pers. comm.). However, the best trawl gear for squid has been described to be a bottom trawl with a vertical opening extending some 6 to 7 meters (18-21 feet) with long wings and mesh sizes from 120 mm getting progressively smaller to 50 mm stretched mesh in the bag of the trawl or codend (Kolator and Long 1979).

Both species of squid are typically caught in the greatest quantities during the day since squid migrate to the surface at night. Therefore, many foreign vessels tow their nets for longer periods of time at night or stop fishing completely until a few hours before sunrise. However, long-finned squid fishing operations are carried out continuously for 24 hours.

In the squid fishery a vessel may tow a trawl net between three to five times each day depending on the vessel's capacity and the target species. Vessels fishing for long-finned squid typically make more tows per day since this fishery operates during the day and night. The duration of a tow ranges from one to five hours. In the late 1970's, foreign vessels fishing for squid had a daily catch from 8 to 45 tons of squid (Kolator and Long 1979).

AREA OF OPERATION: The time of operation for the inshore U.S. mackerel fishery is principally April through May in the mid-Atlantic Bight and from June through July in the Gulf of St. Lawrence. In recent years mackerel landed by domestic fishermen, including those engaged in joint venture fisheries, have been increasingly taken in waters three or more miles from shore; in 1983, 50% of the U.S. catch was taken from offshore areas and in 1985 this amount increased to 87%. Mackerel are concentrated offshore in winter at the edge of the continental shelf east and south of Long Island. Foreign fisheries also target these winter concentrations from January to May. Most of the foreign fishing activity occurs in the mid-Atlantic Bight in areas off southern Georges Bank to the Delaware Bay.

The squid fishery follows similar seasonal migration patterns from shallow coastal waters where squid congregate in late spring through early autumn to the outer edge of the continental shelf in winter. In recent years, the amount of squid taken by U.S. fishermen in waters more than three miles off shore has increased from 70% of the total Atlantic squid harvest in 1982 to 84% in 1985.

LEVEL OF EFFORT: In 1982 there were 1,068 domestic commercial mackerel permits and 892 commercial squid permits issued to U.S. fishermen. Vessels used in these fisheries have an average crew size of four, and average length of 50-55 feet, and a holding capacity of 53 thousand pounds for mackerel vessels and 63 thousand pounds for squid vessels (Mid-Atlantic Fishery Management Council 1983).

The foreign fleet has been far less extensive. Recent numbers of vessels that have operated each year in the foreign squid and mackerel fisheries is given in Table 5. In addition to the countries listed in Table 5, Poland participates in a research fishery for mackerel. Foreign mackerel fisheries have primarily been joint venture fisheries in recent years involving from 2 to 12 vessels from the Netherlands and German Democratic Republic each year. The foreign squid fleet has consisted of between 33 to 51 vessels operating each year in the squid fisheries of Italy, Japan and Spain. In 1986 (through September) 11 vessels were in operation (Gerrior pers. comm).

During 1983-1985, Italy and the German Democratic Republic accounted for more than 99% of the total foreign catch of mackerel. The Netherlands also participated in the mackerel fishery in 1984 and 1985.

In the foreign squid fishery Italy, Spain and Japan have been most dominant in recent years accounting for 82% of the total annual foreign harvest in the U.S. North Atlantic FCZ.

Foreign vessels have been much larger than those used by U.S. fishermen. In 1977, foreign squid vessels used by Spain, Italy and Japan had between 18-54 crew members, were approximately 12-23 feet in length and had a frozen holding capacity of 584-1896 thousand pounds (Kolator and Long 1979).

The number of U.S. vessels specifically participating in joint venture fisheries for mackerel and squid is more difficult to estimate. During the period of 1981-1983 the number of U.S. fishing companies involved in joint venture fisheries rose from one to ten and according to the National Marine Fisheries Service in Massachusetts the number is steadily increasing (Gerrior pers. comm.).

Table 5. List of foreign countries participating in the squid and mackerel fisheries in the northeast Atlantic, number of vessels and landings (thousand pounds) for 1983-1986 (type of fishery is in parentheses).

		Italy (squid)	Spain (squid)	Japan (squid)	Netherlands (mackerel)	Germ.Dem.Rep. (mackerel)
1983	Vessels	15	28	8	-	2
	Landings	16,627	8,911	4,382	-	2,898
1984	Vessels	12	15	6	2	4
	Landings	13,733	7,866	4,127	8,738	12,018
1985	Vessels	9	26	3	7	5
	Landings	5,879	10,433	371	33,841	24,308
1986	Vessels*	5	6	1	-	3
	Landings**	?	?	?	-	?

Source of vessel number- Pat Gerrior, pers. comm. National Marine Fisheries Service, Foreign Fisheries Observer Program, Massachusetts.

Source of landings data- U.S. Dept. Commerce 1986. Fishery of the United States, 1985. NOAA, NMFS. 121 pp.

* number of vessels operating through September 1986
** 1986 landings data not available

INCIDENTAL TAKE/ENTANGLEMENT: During the period of 1978-1986, 215 marine mammals have been incidentally taken in trawls operated by the foreign and joint venture fisheries for squid and Atlantic mackerel in mid-Atlantic offshore waters (Table 6). Of these, over 90% have been reported captured within the past four years. All of these incidents of incidental take have been reported by U.S. observers aboard foreign vessels during fishing operations. Common dolphins and pilot whales have been the most common species taken, comprising 93% of all incidental takes reported. Other species identified include Atlantic white-sided dolphins, bottlenose dolphins, a Risso's dolphin and a juvenile right whale.

Researchers at the Northeast Region Office of the National Marine Fisheries Service are gathering data on incidental take of marine mammals in these fisheries to determine better how such incidents occur and if incidental takes may be affecting marine mammal populations. From analyses of incidental take data it has been determined that taking of common dolphins and pilot whales is related to the species and fishery involved. Common dolphins are caught more frequently at night during squid fishing operations. Pilot whales, on the other hand, are more likely to be taken in trawls during the day in both squid and mackerel fisheries (Waring pers. comm.).

In terms of the foreign countries involved it appears that the fishing practices used by certain countries may be more likely to capture marine mammals incidentally. For example, the long-finned squid fisheries of Italy, Spain and Japan all operate within the same fishing area at the same time of year according to U.S. fishing regulations. Italy, however, has caught much higher numbers of marine mammals, thus indicating that some fishing techniques used by Italy may be more responsible for the higher level of incidental catch. When the Netherlands was participating in the foreign mackerel fishery in 1984 and 1985 this country caught 50 marine mammals. The German mackerel fishery had the same number of vessels as the Netherlands during this period but only one incidental taking of a marine mammal was reported by observers, thus indicating that the gear or techniques used by the Netherlands may have been responsible for the greater numbers of incidental catch. However, the German Democratic Republic, which has been fishing for mackerel since 1983, reported that a substantial number (31) of marine mammals had been taken for the first time in 1986. The NMFS Northeast Region Office plans to investigate the type of gear used by these foreign countries to determine if certain characteristics of the trawl gear may be responsible for higher levels of incidental takings of marine mammals.

The countries participating in these fisheries are required to have permits from the NMFS to incidentally capture a certain number of marine mammals each year as specified in the permit. For example, in 1985 Japan was permitted to take 15 cetaceans during trawling operations including 5 pilot whales, 5 harbor porpoises and 5 Atlantic white-sided dolphins (U.S. Dept. Commerce 1985). During the 1985 fishing season Japan incidentally captured one common dolphin. Italy also had a permit originally to take 10 cetaceans in 1985, but an additional 25 animals were requested and granted later in the season (Hollingshead pers. comm.). However, Italy incidentally captured 39 marine mammals during 1985. The German Democratic Republic also had a permit to take up to 10 cetaceans but captured a total of 31 during the 1986 fishing season. According to the National Marine

Fisheries Service Office of Endangered and Protected Species (Hollingshead pers. comm.) no country has been prosecuted for exceeding its marine mammal permit quota. Rather, the past record has shown that a country which has exceeded its quota typically applies for an additional number of marine mammals to be taken to cover this additional incidental take. According to the guidelines of the general permit system in the North Atlantic, as long as the number of marine mammals taken by all fisheries in this area does not exceed one-half of the annual reproductive yield for each species, populations of these species will not be affected (Hollingshead pers. comm.).

The general permit system mandates that U.S. observers be placed on foreign vessels fishing within U.S. waters. Hence, observer reports are presently being used to monitor the levels of incidental takes of marine mammals in foreign mackerel and squid fisheries operating in the northeast Atlantic Ocean. However, U.S. fishermen, including those participating in joint venture fisheries, are not permitted to incidentally capture any marine mammals during fishing operations. More importantly, U.S. fishing operations do not have observer programs, so that incidental take is not required to be reported but it is known to occur. For instance, in 1986 of the 31 marine mammals reported taken during mackerel fishing operations of the German Democratic Republic, 15 common dolphins were actually taken by U.S. vessels participating in a joint venture with this country. The reason that this incidental take by a U.S. vessel was reported is that the animals were transferred in the net along with fish to the foreign vessel and were thereby recorded in U.S. observer reports.

The U.S. mackerel and squid catches in offshore waters has increased to the point where most of the U.S. catch is taken three or more miles from shore in similar areas and times as the foreign fleet. Foreign fisheries are regularly reported to take marine mammals, and pilot whales and common dolphins in particular, but essentially nothing is known about the extent or frequency of incidental taking of marine animals by U.S. fishermen.

Table 6. List of marine mammals incidentally taken in the foreign trawl squid and mackerel fisheries in the northeast Atlantic, 1978-1986.

	Pilot Whale	Common Dolphin	White-sided Dolphin	Bottlenose Dolphin	Other
Italy (squid)					
1978-1982	3	-	-	-	1-baleen whale
1983	-	-	-	-	
1984	2	3	2	-	
1985	-	39	-	-	
1986	3	33	-	-	1-Risso's dolphin
Spain (squid)					
1978-1982	4	-	-	-	1-baleen whale
1983	1	-	-	-	1-right whale
1984	7	1	-	-	
1985	2	2	-	-	
1986	-	-	-	-	
Japan (squid)					
1978-1982	1	1	-	-	
1983	-	-	-	-	
1984	-	-	-	-	
1985	-	1	-	-	
1986	-	-	-	-	
Mexico (squid)					
1978-1979	1	-	-	-	1-cetacean sp.
German Dem.Rep. Joint Venture (mackerel)					
1983	-	4	-	-	
1984	1	-	-	-	
1985	-	-	-	-	
1986	15	17	-	-	
Netherlands (mackerel)					
1984	11	-	-	-	
1985	31	5	-	3	

(cont.)

Table 6. (Cont.) List of marine mammals incidentally taken in the foreign trawl squid and mackerel fisheries in the northeast Atlantic, 1978-1986.

	Pilot Whale	Common Dolphin	White-sided Dolphin	Bottlenose Dolphin	Other
Poland (mackerel)					
Joint Venture					
1980-1982	1	-	-	1	
1983	3	-	-	-	
1984	1	-	-	-	
1985	-	-	-	-	
1986	1	3	-	-	
USSR (hake)					
1978-1979	1	-	1	1	1-cetacean
Italy (hake)					
1985	-	4	-	-	
TOTAL	89	113	3	5	6

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Fisheries of the Mid-Atlantic

New York Pound Net Fishery

TARGET SPECIES: The pound net fishery of New York targets a variety of species depending on seasonal availability. Major species taken include bluefish, butterfish, Atlantic mackerel, scup or porgy, and sea trout.

In 1977, which is the most current official estimate of pound net landings in New York, 17.6 million pounds of finfish was landed in the state, of which approximately 2.5 million pounds valued at $563,860 was taken in pound nets. Landings of Atlantic mackerel, scup, and sea trout comprised over one half of the 1977 total pound net catch.

GEAR: A pound net functions as a large stationary trap constructed of netting supported by poles or stakes. The "head" of the pound net is the trap portion, with netting on the sides and bottom. The "bay" functions to funnel fish into the head. The "hedging," also referred to as the "leader," consists of a single panel of heavy twine and large mesh netting hung from stakes in line with the openings of the head and bays which diverts fish swimming along shore into the pound. The head is usually placed in deeper areas of channels, with the bay and hedging directed toward shallower water or at a right angle to the shore or channel. Pound nets used in New York waters primarily use the former configuration with the hedging extending from the shoreline out to the pound.

AREA OF OPERATION: The pound net fishery operates primarily in the coastal bays of eastern Long Island including Gardiners Bay, Block Island Sound, Long Island Sound and smaller harbors. Fishing extends from early spring through fall with Atlantic mackerel, whiting, herring, weakfish and other species taken during the spring months and bluefish primarily caught in fall.

LEVEL OF EFFORT: In 1977, approximately 100 pound nets were used by 63 fishermen in New York, the majority of which used either small boats or operated from the shore. Although more recent official information on effort is not available for this fishery, at present over 100 fishermen are estimated to be using pound nets (Sadove pers. comm.). Each fisherman typically uses one or two nets but some have been noted to set as many as 15 nets.

INCIDENTAL TAKE/ENTANGLEMENT: Recently, researchers at the Okeanos Ocean Research Foundation in Hampton Bays, New York, have received numerous reports of sea turtles, particularly Kemp's ridley turtles, entrapped in pound nets in eastern Long Island. Officially documented cases of entanglements that have been compiled by Okeanos are given below. According to Okeanos Research Director, Sam Sadove (pers. comm.), the number of documented cases, however, does not indicate the real extent of the problem. Fishermen have indicated that Kemp's ridleys are caught regularly with each fisherman catching 10 to 20 animals each year. With over 100 fishermen operating pound nets this problem may be significant. Although the majority of the animals listed below were released alive, it is not known whether recent findings of an unusually large number of stranded Kemp's ridleys in Long Island may be attributed in part to fisheries interactions. According to Sadove, pound net fishermen have been extremely cooperative in reporting incidental takes so that the animals may be released unharmed. However, because the incidental taking of all species of sea turtles is illegal, researchers believe that not all incidents are reported for fear of prosecution.

At present researchers do not know the total number of turtles that are caught each year, or what percentage of these animals are caught several times. Currently, Okeanos is planning to conduct a mark-recapture project in 1987 for Kemp's ridley turtles caught in pound nets to determine the extent of this problem. Okeanos hopes to obtain a permit for pound net fishermen so that they will not be prosecuted if they capture Kemp's ridleys incidentally. In turn, fishermen who obtain permits must report incidental takes of sea turtles to Okeanos so that important biological information on captured turtles may be obtained and live animals can be tagged and released.

Date	Species	Location	Condition
7/17/86	Kemp's ridley	Orient Point, Long Island Sound	?
7/28/86	Kemp's ridley	Orient Point, Long Island Sound	?
8/4/86	Kemp's ridley	Orient Point, Long Island Sound	?
8/7/86	Kemp's ridley	Orient Point, Long Island Sound	?
8/12/86	Loggerhead	Carmens River, Brookhaven	alive/released
8/13/86	Kemp's ridley	Orient Point	alive/released
8/15/86	Green	Orient Point, Gardiners Bay	alive/released
8/23/86	Loggerhead	Orient Point	alive/released
9/19/86	Green	Northwest Harbor, East Hampton	alive/released
10/24/86	Kemp's ridley	Northwest Harbor, East Hampton	alive/released
10/28/86	Loggerhead	North Haven, Sag Harbor	alive/released
11/2/86	Loggerhead	Northwest Harbor, East Hampton	alive/released
11/9/86	Kemp's ridley	Northwest Harbor, East Hampton	alive/released

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Delaware Gill Net Fisheries

TARGET SPECIES: The gill net fisheries of Delaware include both set and drift gill nets. Historically, the principal species taken in set gill nets in Delaware have included sea trout, striped bass, bluefish, croaker, white perch and shad. In 1984, however, a moratorium was placed on the commercial harvesting of striped bass. Drift nets have been used primarily for shad, sturgeon and other fish species.

In 1977, approximately 415,000 pounds valued at $105,000 was taken in set gill nets in Delaware. In 1977, 64,400 pounds of shad was landed in shad drift nets valued at $13,296. Drift nets for other species including sea trout, spot, striped bass and whiting landed 66,500 pounds valued at $16,539. Historically, the level of effort in the gill net fishery has closely followed the size of weakfish stocks.

GEAR/AREA OF OPERATION: In general, drift nets have been used in areas of slow moving water in downstream areas of rivers to take large quanitities of weakfish and croaker, however drift nets are also used to catch shad. Delaware state law requires that all drift gill nets must be continuously attended by a fisherman. In addition, from May 10 to September 30 drift gill nets may not exceed 3,000 feet in length but there are no regulations for other times of the year.

Fixed or anchored gill nets are typically set in upstream tidal areas for anadromous species such as shad. All set gill nets are required by law to be attended every 48 hours. Areas within a one-half mile sector at the mouths of major tributaries to the Delaware River and Delaware Bay are closed to any kind of fixed fishing gear including gill nets.

Between May 1 and November 30 the area within one-half nautical mile from shore along the Delaware Bay and the Atlantic coastline of Delaware from Cape Henlopen to Broadkill Beach is closed to fishing. There are also seasonal closures to gill net fishing primarily at the mouths of tidal creeks and rivers. In all tidal waters except for the Atlantic Ocean, the maximum legal length of a gill net is 600 feet, and a series of nets may not cover a distance more than 1,500 feet.

LEVEL OF EFFORT: The most current information on the number of gill nets used in Delaware is for 1977. At that time the majority of fishermen used set gill nets; 94 fishermen used 59 set gill nets. An additional 65 fishermen used 14 drift gill nets for shad and 23 drift gill nets for other fishes. The majority of all gill net fishermen operated out of small motor boats.

INCIDENTAL TAKE/ENTANGLEMENT: Loggerhead and Kemp's ridley sea turtles are taken in gill nets in Delaware. Table 7 lists those species taken in nets and other reports of incidentally taken species. According to the Delaware Department of Natural Resources and Environmental Control (Thomas pers. comm.) although there have been few documented reports of entanglements it is believed that some of the strandings that occur for unknown reasons in Delaware are due to entanglement. Future studies of autopsied animals are planned to determine the cause of mortality of these animals.

Table 7. Incidental take/entanglement of sea turtles and marine mammals in Delaware.

Date	Species	Location	Condition	Remarks
Sea Turtles				
9/1/79	Kemp's ridley	?	released	caught
9/1/79	Kemp's ridley	?	released	caught
9/1/79	Kemp's ridley	mouth of St. Jones, 1/2 mile off Fowler's Beach in 10 ft. of water	released	reported caught
10/15/79	Kemp's ridley	Port Mahon boat ramp	dead	caught in net, dumped on ramp
5/28/80	Kemp's ridley	off Little River	?	in net
6/8/81	Loggerhead	Little River Port Mahon	drowned	caught in crab trap line
7/14/81	Loggerhead	Port Mahon	released	caught in net
7/15/81	Loggerhead	Port Mahon	released	caught in net
8/9/81	Loggerhead	Port Mahon	released	caught on hook and line
9/1/81	Loggerhead	1 mile east of St. Jones River	?	caught
9/2/81	Loggerhead	1 mile off St. Jones Creek	released	caught
7/11/84	Loggerhead	1/2 mile off Dewey Beach	released	caught in drift gill net
7/11/84	Loggerhead	1/2 mile off Dewey Beach	released	caught in drift gill net
6/26/86	Loggerhead	east of Bowers Beach	released	caught in drift gill net
7/15/86	Hawksbill	off Port Mahon Murderkill	released	caught in leg, hook and line
Marine Mammals				
5/10/85	bottlenose dolphin	Cape Henlopen	dead	incidental catch Source: M. Hare
1/31/86	Risso's dolphin	Cape Henlopen	dead	scratches all over body

Sources: Janis Thomas, pers. comm., Delaware Department of Natural Resources and Environmental Control, Dover, DE (unpublished data) except where otherwise noted.

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Chesapeake Bay Pound Net Fishery

TARGET SPECIES: The Chesapeake Bay finfish fisheries are conducted by three principal gear types (excluding the menhaden fishery): gill nets, haul seines, and pound nets. In the early 1950's, the Chesapeake pound net fishery landed the greatest weight of fish as compared to any other gear used in the Chesapeake. Of the 89.6 million pounds of fish landed in Virginia in 1951 (other than purse seines) pound nets accounted for 45.5 million pounds--approximately one half (Reid 1955). Major fish species landed in pound nets include alewives, bluefish, croaker, spot, shad, butterfish, sea trout, striped bass, and white perch.

In recent years, although the pound net fishery has decreased due primarily to economic factors and dwindling fishery resources it remains a principal gear type used in the Chesapeake. In 1977, which is the most current estimate of pound net catches by state, of the 544 million pounds of fish landed in the state of Virginia, pound nets accounted for 61 million pounds--approximately 11%. The pound net fishery in Maryland accounted for 8.8 million of the 16 million pounds (55%) of finfish caught in 1977. In comparison, gill nets and haul seines landed approximately 8 million pounds of the total finfish catch in Virginia in 1977, and 2 million pounds in Maryland.

The value of pound net fishery landings in 1977 was $2.8 million of the $27 million Virginia finfish catch and $358,000 of the $3 million Maryland finfish catch. Pound nets are also used in the Chesapeake to catch crabs.

GEAR: A pound net consists of a large bag of netting used for impounding fish with a series of nets hung from poles to divert fish into the pound. The "head" of the pound net is the impounding structure used to entrap fish. The head is usually placed in deeper areas of channels with the "bay" and "hedging" directed toward shallower water or at a right angle to the shore or channel. The "hedging," also referred to as the "leader," consists of a net of heavy twine and large mesh hung from stakes in line with the openings of the head and bays. The function of the hedging is to divert fish swimming along shore into the pound. The hedge may cover as much as 1,000 feet with mesh sizes ranging from 6 to 16 inch stretch mesh.

In some localities a "string" hedge is used when fishing for shad. This consists of an upper (surface) and lower (bottom) rope with twine tied vertically between at intervals of approximately 6 inches reaching from the surface to the bottom. In addition, some nets use longitudinal twines spaced from 4 to 6 feet across the vertical twines.

AREA OF OPERATION: The pound net fishery operates within the Chesapeake Bay and its tributaries, traditionally from spring through autumn.

LEVEL OF EFFORT: In 1977, 123 pound nets were used by 258 fishermen engaged in the Maryland pound net fishery for finfish and 425 pound nets were used by 491 fishermen in Virginia. The majority of pound net fishermen in Maryland used small motor boats, whereas in Virginia pound netters used both motor boats and larger vessels (U.S. Dept. Commerce 1984).

INCIDENTAL TAKE/ENTANGLEMENT: The timing of the Virginia pound net fishery coincides with the time when turtles are most abundant in the Chesapeake. Since 1979 researchers at the Virginia Institute of Marine Science have been recording sea turtle mortalities, including loggerhead, Kemp's ridley and leatherback turtles (Musick et al. 1984). The majority are loggerheads, with ridleys making up less than 5% of the total number. Maximum mortalities occur in late May and early June with between 80-200 sea turtles reported dead in early June each year (Lutcavage and Musick 1985).

Where cause of the death is apparent, entanglement and drowning or suffocation in pound net hedging is a major factor. For the 285 loggerheads autopsied between 1979 and 1984, approximately 20% of the mortalities were attributed to pound nets. Seventy percent of the mortalities were undetermined. It has been estimated that this fishery is responsible for a minimum of 50 loggerhead deaths each year which could be even higher if some undetermined mortalities are actually pound net related (Musick et al. 1984). The ease with which turtles are caught in this gear is illustrated by the fact that 389 sea turtles were incidentally captured in pound nets by cooperating fishermen for purposes of tagging in 1980-81 (Lutcavage and Musick 1985).

There are two possible ways in which sea turtles may be captured in pound nets. One can result from entanglement in the hedging mesh of a net which usually results in drowning. The other may result from impoundment in the head of the net which often results in the live capture of turtles that are confined but often released alive (Lutcavage and Musick 1985).

Researchers have found that the capture of turtles appears to be related to certain characteristics of the net and the location of a set. Nets set along channel edges in areas of strong tidal currents, and especially deep water nets near large-scale physical features, are likely to catch and drown turtles. Large mesh hedgings (12-16 inch stretch mesh) are more likely to capture turtles as compared to smaller mesh (6-10 inch stretch mesh). In addition, nets with vertical stringers are particularly prone to capture and drown turtles in areas of strong tides.

Hedging deaths may also be related to turtle movements through areas where nets with large open mesh hedging are set. Local currents in the vicinity of pound nets may increase the likelihood of entanglement especially if turtles are unable to avoid these due to disease or physical stress. Most turtle mortalities occur when the turtles enter the Bay after a long migration from the south. At this time turtles have been noted to be in extreme physical distress.

In addition, Musick et al. (1984) noted that turtles linger near pound nets which may be attributed to the fact that pound nets are encrusted with epibiotic growth which in turn attracts crustaceans thereby acting as a concentrated food source for the turtles. Horseshoe crabs, another prey species of turtles, also become concentrated at the bottom of these nets.

Records maintained by the Smithsonian show that Atlantic bottlenose dolphins are also incidentally taken in pound nets in the Chesapeake although records on such occurrences are scarce (Hare pers. comm.). In September 1985, a dolphin was found dead in a pound net in the area of Lynnhaven Inlet, Virginia. In September 1984, another was reported entangled and dead in a "fish trap," a term that could be used interchangeably with a pound net.

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Chesapeake Bay Gill Net Fisheries

TARGET SPECIES: Major species taken in gill nets in Maryland and Virginia include bluefish, sea trout, shad, striped bass and white perch with considerable quantities of spot and croaker also taken in Virginia.

In 1977, gill nets used in Maryland landed 2,754 thousand pounds of finfish valued at $1.17 million. This catch by gill nets contributed 17% to the total state finfish catch by weight and 40% in value. Virgina gill net landings in 1977 accounted for only 2% of the state's finfish catch by weight and 6% in value with 9,674 thousand pounds valued at $1.57 million. In both states set gill nets accounted for more landings than drift gill nets.

GEAR: In the Cheaspeake Bay region, set and drift gill nets are used throughout the Bay and in coastal areas bordering the Atlantic. No descriptions of the gill nets used in this fishery were found. However, during 1981-82, Maryland Department of Natural Resources Tidewater Administration personnel (Lukacovic pers. comm.) observed gill nets that ranged between 520 to 1,050 feet in length with a single vessel using from 5 to 17 gill net units. These nets were left to fish for 24 to 96 hours.

AREA OF OPERATION: The majority of species caught in gill nets are landed within the Chesapeake Bay proper as opposed to the ocean and other bays and creeks in this area. During the 1982-83 fishing season, Maryland Department of Natural Resources personnel observed commercial gill net fishing vessels in the Chesapeake and its tributaries. These vessels were observed during the months of December through March.

LEVEL OF EFFORT: In 1977, there were 2,354 fishermen using 1,990 gill nets in Maryland and 3,047 fishermen operating 4,952 gill nets in Virginia.

INCIDENTAL TAKE/ENTANGLEMENT: Although there are no programs directed at incidental take in the gill net fishery of the Chesapeake Bay region, marine mammals have been reported drowned in gill nets in the lower portion of the Chesapeake Bay and along the Atlantic. The earliest record avialable is that of a humpback whale caught in a gill net at Cape Henry, Virginia in 1975 (Perkins and Beamish 1979). Other records maintained by the Smithsonian Institution's Marine Mammal Events Program include a minke whale found dead wrapped in a fishing net in Onancock and a bottlenose dolphin stranded dead with a gill net around its tail in Norfolk, Virginia in 1982 (Hare pers. comm.).

In 1986, an unusually high number of dolphin mortalities occurred in Virginia and were attributed to gill nets (Zaneski 1986). As of July, twelve dolphins had stranded in Virginia Beach and the southern Chesapeake, five of which came ashore in southern Virginia Beach during a two week period in May. Three of these animals had obvious signs of gill net injuries, and one stranded at Back Bay National Wildlife Refuge entangled in a gill net.

Other reports of incidental taking of marine mammals in fishing gear in Virginia are given in Table 8. For many of the reports in Virginia the type of fishing gear involved was not specified. Reports from Maryland were not available.

Table 8. Reports of marine mammal fishery interactions in the Chesapeake Bay region.

Date	Species	Location	Condition	Remarks	Source
2/25/75	humpback whale	Cape Henry, VA	?	caught in gill net	Perkins and Beamish (1979)
7/28/77	minke whale	Onancock, VA	dead	fishing net wrapped around rostrum	SEAN v.2(7)
11/80	bottlenose dolphin	Virginia Beach	dead	covered with net marks	Reynolds(1985)
9/12/82	bottlenose dolphin	Ocean View, VA	dead	stranded dead in gill net	M. Hare
3/23/84	harbor porpoise	Sandbridge, VA	dead	incidental take	M. Hare
9/9/84	bottlenose dolphin	Lynnhaven Inlet, VA	dead	incidental take	M. Hare
11/20/84	striped dolphin	Buckroe Beach, VA	dead	incidental take	M. Hare
7/16/85	bottlenose dolphin	Lynnhaven Inlet,VA	dead	net/rope marks	M. Hare
7/17/85	bottlenose dolphin	Norfolk, VA	dead	net/rope marks	M. Hare
9/23/85	bottlenose dolphin	Virginia Beach VA	dead	encircling impression around neck	M. Hare
5/11/86	bottlenose dolphin	Back Bay Nat'l Wildlife Refuge	dead	possible net marks on snout	M. Hare

Note: See references for sources.

In the upper portion of the Chesapeake Bay and its tributaries waterfowl are incidentally taken in gill nets. The Maryland Department of Natural Resources Tidewater Administration reported that as many as 52 waterfowl may be taken by a single fisherman in one day (Lukacovic pers. comm.). During samplings of 13 gill net vessels in the Chesapeake Bay and tributaries a total of 162 waterfowl were incidentally taken including 115 scaup, 29 ruddy and 18 canvasback ducks (Table 9). This waterfowl "by-catch" was observed during the winter of the 1982-83 fishing seasons. In addition, in 1983 eleven days of observations were spent on commercial vessels on the Chesapeake Bay proper and twelve days were spent on the tributaries (Susquehanna, Bush, Patuxent and Choptank). While no waterfowl mortalities were observed in the tributaries, waterfowl were observed dead in gill nets on seven days in the Chesapeake but the number was not specified.

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Table 9. Incidental take of waterfowl in set gill nets fished in the Chesapeake Bay, 1981-82.

Date	Species	Number	Location	Amount of Net Fished/Duration
12/30/81	scaup	2	Howell Pt.	10 boxes*/48 hours
2/16/82	scaup	10	Potomac River Riverside	6 sets/48 hours
	canvasback	7		
	ruddy duck	2		
2/24/82	scaup	38	Pooles Island	17 boxes/48 hours
	canvasback	2		
	ruddy duck	1		
3/2/82	scaup	32	Potomac River Blossom Pt.	12 boxes/24 hours
	ruddy duck	14		
	canvasback	6		
3/9/82	scaup	10	Pooles Island	11 boxes/72 hours
3/17/82	scaup	2	Potomac River Blossom Pt.	10 sets/48 hours
	ruddy duck	5		
	canvasback	1		
1/13/83	scaup	2	Love Pt.	5 stands (1050 ft. each)/96 hours
1/25/83	scaup	1	Love Pt.	7 boxes (600 ft. per box)/72 hours
	ruddy duck	3		
	canvasback	2		
2/7/83	scaup	13	Swan Pt.	8 boxes and 2 stands/96 hours
2/10/83	scaup	5	Love Pt.	7 boxes/ 96 hours
3/2/83	ruddy duck	1	Miller's Is.	5 stands (520 ft. each) and 2 boxes/24 hours
3/8/83	ruddy duck	1	Miller's Is.	7 stands (520 ft. each) and 2 boxes/48 hours
3/17/83	ruddy duck	2	Miller's Is.	6 stands (520 ft. each) and 5 boxes/48 hours
TOTAL		162		

* 900 feet per box, unless otherwise noted.

Source: Rudy Lukacovic, pers. comm., Maryland Department of Natural Resources, Tidewater Administration, Annapolis, MD.

Carolina Gill Net Fisheries

TARGET SPECIES: The American shad, the largest member of the herring family in North America, is one of the best known fishes of the U.S. east coast and is targeted by commercial and recreational fishermen. This species is most abundant from North Carolina to Connecticut and is an anadromous fish which in the spring ascends from the ocean to spawn in rivers and streams. The female shad is more important commercially because of the demand for roe.

Prior to the late 1800's sturgeons were also very common in North American waters, but were of little commercial value. However, with the increasing demand for caviar and smoked sturgeon, this species became popular and the prices of sturgeon rose sharply. Consequently, in many places they have been overfished to the point where they have been practically exterminated (Parks 1978).

Commercial fisheries for shad in the southeastern United States have declined during the past century. In 1982, 853,000 pounds of shad valued at $577,000 were taken in the states of North Carolina, South Carolina and Georgia. The North Carolina shad harvest peaked near 9 million pounds in 1896, but declined to about 400,000 pounds in 1982 (Facey and Van Den Avyle 1986). The catch in Georgia exceeded 1.3 million pounds in 1908, but was less than 200,000 pounds in 1982. The trend has been the same in South Carolina with 243,000 pounds taken in 1982.

In 1977, approximately 45% of the shad catch was taken in set and drift gill nets and 52% were taken in pound nets. Georgia's shad fishery landed 118,000 pounds valued at $84,000 in 1977 with gill nets being the only gear type. In South Carolina, approximately 80,000 pounds of shad valued at $54,000 were taken in 1977, also solely by gill nets.

Historically, South Carolina has been the leading producer of sturgeon in the South Atlantic. In 1977, 115,000 pounds of sturgeon valued at $26,000 were landed in this state. However, in 1985, oceanic sturgeon fishing in South Carolina was prohibited, and in 1986 the State's prohibitions extended inshore in response to reductions in sturgeon stocks. Previously, the open season for catching sturgeon in South Carolina was from March 1 to October 1 (S.C. Division of Marine Resources 1984). In North Carolina, sturgeon landings in 1977 were 30,000 pounds valued at $5,000. Georgia's sturgeon fishery was smaller with 3,000 pounds, valued at $1,000.

GEAR: Gill nets have recently become the major gear used in the shad fishery (Facey and Van Den Avyle 1986). Shad gill nets are either set nets or, more commonly, drift nets. In South Carolina drift and set gill nets are now the only gear fished commercially (Ulrich et al. 1979). According to South Carolina Wildife and Marine Resources personnel (Moise pers. comm) these nets average around 300-400 yards each.

The minimum legal mesh size for commercial gill netting of American shad in the South Atlantic States is between 11.4 and 14.0 cm (4.3-5.5 inch) stretch mesh (Facey and Van Den Avyle 1986). Regulations controlling the number and length of nets vary within and among river systems but generally where regulations exist such as in the Savannah River and the Edisto River only two gill net sets are permitted. In Ossabaw Sound, and the offshore waters of certain rivers in Georgia only drift gill nets may be used.

A law that recently became effective in South Carolina states that:

> "It is unlawful to use or set gill nets having a stretch mesh size between three and one half inches and ten inches in the Atlantic Ocean from the shoreline seaward to the three mile territorial limit during the open season for taking shad. During the open fishing period all nets must be drift fished and may not be staked, anchored, or otherwise set in a fixed position."

In addition, the State requires that all drift gill nets over one hundred yards in length used in the Atlantic Ocean within three miles of shore must be marked and tended by fishermen. Also, it is unlawful to place or set any stationary or fixed nets, including gill nets, pound nets or seines within two hundred yards of any net previously set.

In Georgia all set nets for shad must have one end secured to a stream bank and drift gill nets may be no longer than 1,000 feet in salt waters. Sturgeon gill nets must be at least 6 inch stretch mesh.

AREA OF OPERATION: Gill net fisheries for shad and sturgeon operate in coastal waters. Along the South Atlantic, American shad begin their spawning migration into rivers during winter and early spring. The spawning runs begin in early January in Georgia and South Carolina and in January and February in North Carolina. Some spawning runs continue into late April or May. In North Carolina shad fishing is heaviest in January through April. The major shad producing rivers in North Carolina are the Tar-Pamlico, the Cape Fear, the Northeast Cape Fear, the Chowen, and the Neuse. The open season for shad fishing in South Carolina varies somewhat among rivers but generally is conducted from February 1 to April 30. The principal rivers in South Carolina are Winyah Bay and its major tributaries, the Waccamaw and Pee Dee Rivers. Other waters supporting shad fisheries in South Carolina are the Santee River, Charleston Harbor, the Edisto River, and the Combahee, Ashepoo and Coosawhatcie Rivers. The season in Georgia is closed from May 1 through December 31 with the open season established within the period January 1 through April 30. The Savannah River supports shad runs in South Carolina and Georgia. Other Georgia rivers include the Ogeechee, Atlamaha, Satilla and St. Mary's.

Sturgeon also enter fresh waters to spawn in spring and summer. The sturgeon season in Georgia is from January 15 to July 1.

LEVEL OF EFFORT: The most recent compilation of information on effort in these fisheries is for 1977. Although the majority of North Carolina's shad was taken in pound nets, over two thousand gill nets were used by 647 fishermen. Sixteen of these nets were shad drift nets.

In comparison, the South Carolina and Georgia gill net fisheries are less extensive. In South Carolina, 69 fishermen fished part time with 62 gill nets. While 29 of South Carolina's gill nets were shad drift nets, approximately 75% of the shad fishery catch in South Carolina was obtained by drift gill nets, with the remaining catch taken in anchored or set nets. In Georgia, 150 fishermen used gill nets, the majority of which (131) used shad drift gill nets which numbered 163. Drift gill nets in Georgia are preferred over set gill nets with 82% of the Georgia shad landings in 1979-1982 taken in drift gill nets (Essig 1983, as cited by Facey and Van Den Avyle 1986).

A survey of licensed shad fishermen in South Carolina showed that less than 5% relied on commercial fishing to make a living, and that even these fishermen derived less than 10% of their annual income from shad fishing (Ulrich et al. 1979, as cited by Facey and Van Den Avyle 1986). Most of those surveyed fished for only recreation and home consumption.

INCIDENTAL TAKE/ENTANGLEMENT: Historically, the shad and sturgeon gill net fisheries in the Carolinas may have resulted in at least 15 dolphin deaths each year (Reynolds 1985). These mortalities appear to occur mostly in late winter-early spring during the peak season of this fishery. According to Reynolds (1985) who conducted a study of interactions between bottlenose dolphins and fisheries in the southeastern United States, the problem has been most noticeable in South Carolina, which may be attributed either to the severity of the problem in this state or to differing levels of investigation. Tables 10 and 11 list all reports of incidental capture and/or entanglement of marine mammals in nets in the states of North Carolina and South Carolina. Only one record of a bottlenose dolphin entangled and killed in a gill net was found by Reynolds (1985) for the state of Georgia. This incident occurred in the early 1970's.

Landing data for 1977 indicate that shad fisheries in Georgia, North Carolina and South Carolina were similar in productivity, but that sturgeon fishing was greatest in South Carolina where most reported dolphin incidental taking occurred. According to Reynolds (1985) these data suggest that sturgeon fishing was the primary cause of dolphin incidental mortality.

Crouse (1982) noted that some sea turtle mortality in South Carolina is associated with gill net fishing. Mortality increases in spring, with a peak in April. This coincides with dolphin mortalities and was attributed to the shad and sturgeon fisheries which operate at this time.

The South Carolina Wildlife and Marine Resources Department (SCWMRD) (Murphy pers. comm.) reported that oceanic gill nets cause the mortality of loggerhead, Kemp's ridleys and green sea turtles as well as Atlantic sharpnose sturgeon, which are endangered, and common loons, red-throated loons, scaups, mergansers, cormorants and other birds. In 1983, SCWMRD recorded 60 loons, 7 porpoises and 14 sea turtle mortalities attributed to gill nets. At the beginning of 1984 (through February 23) a minimum of 200-250 bird mortalities, the majority of which were loons, were attributed to set gill nets for shad (Murphy pers. comm.).

According to reseachers at the Belle Baruch Marine Laboratory in Georgetown, South Carolina, three to five lost gill nets are found each year when the shad season is finishing up (Allen pers. comm.). These gill nets are almost always found with entangled animals including crabs, sharks, cormorants, mergansers, grebes and some sea turtles. When these nets drift into estuarine areas they also entangle diamondback terrapins.

Recent legislative actions in South Carolina have eliminated the sturgeon gill net fishery, and prohibits the use of set and untended offshore gill nets for shad. Consequently, dolphin mortality decreased to two dolphins in the 1985 fishing season in the Georgetown, South Carolina area. According to Reynolds (1985) the type of gill netting most likely to cause future dolphin mortality in South Carolina is inshore shad gill netting, and this may also be true for other marine wildlife. Some oceanic shad fishermen have recently moved their operations inshore where they are not subject to the restrictions of the bill (Reynolds 1985).

In addition, several fishermen in South Carolina use set gill nets for shark which are similar to shad and sturgeon nets and are used in the same areas. Therefore, these nets may likely be taking marine mammals, sea turtles and birds incidentally (Murphy pers. comm. 1986). Information on mortalities caused by this fishery, however, is presently unavailable.

Table 10. Records of marine mammals incidentally caught or entangled in gill nets in North Carolina.

Date	Species	Location	Condition	Remarks	Source
5/12/75	bottlenose dolphin	Nags Head	dead	drowned in gill net	Reynolds
5/12/78	bottlenose dolphin	Nags Head	dead	drowned in gill net	SEAN v.3(5)
5/12/78	bottlenose dolphin	Nags Head	dead	drowned in gill net	SEAN v.3(5)
8/18/79	harbor porpoise	Corolla Beach	dead	definite net marks on body	SEAN
mid-1981	bottlenose dolphin	Beaufort Inlet?	dead	tangled in gill net; killed with hammer	Reynolds
1/81	bottlenose dolphin	Emerald Island	dead	net marks; head missing	Reynolds
4/82	bottlenose dolphin	Beaufort	dead	drowned in net	Reynolds
8/81	bottlenose dolphin	Atlantic Beach	dead	incidental take?	Reynolds
4/5/83	right whale	Wrightsville Beach	alive	tangled in net; released with 10 ft. net on it	M. Hare
1/84	bottlenose dolphin	Pine Knoll Shores	dead	net marks covered carcass	Reynolds
4/84	bottlenose dolphin	Dare	dead	incidental take	Reynolds
5/26/84	bottlenose	Fort Fisher	?	incidental take	M. Hare
4/11/85	bottlenose dolphin	Hatteras Is. Shores	dead	possible net marks on snout	M. Hare
3/4/86	harbor porpoise	Wrightsville Beach	dead	rope burns	M. Hare

Note: See references for complete citations of sources.

Table 11. Records of marine mammals incidentally caught or entangled in gill nets in South Carolina (Reynolds 1985).

Date	Species	Location	Condition	Remarks
1952	bottlenose dolphin	Port Royal Sound	2 killed	drowned in sturgeon nets
Spring 1978	bottlenose dolphin	Georgetown, SC	4-5 killed	drowned in sturgeon nets
April-May, 1979	bottlenose dolphin	Georgetown	13 killed	drowned in sturgeon nets
1978-1982	bottlenose dolphin	Ocean and mouths of large rivers from Cape Fear, NC to Edisto Beach, SC	at least 25 dead (not known if this is annual or total count)	ocean gill net fishing for shad and sturgeon caused entanglement in gill net, monofilament, and multifilament
1978-1982	bottlenose dolphin	same location as above	numerous animals	severe damage to nets especially monofilament
1978-1984	bottlenose dolphin	Myrtle Beach & N. Myrtle Beach	4 killed	four separate cases of entanglement in shad and sturgeon nets
Feb-May 1978 to 1984	bottlenose dolphin	North Inlet	10-15 dead/yr	drowned in large commercial sturgeon gill nets
Jan-April yearly	bottlenose dolphin	North coast of SC, centered on Winyah Bay	12 dead/yr	drowned in shad and sturgeon nets
1979-1983	bottlenose dolphin	Charleston County & Georgetown Co.	25 killed	entangled in sturgeon net

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Fisheries of the Southeast Atlantic and Gulf of Mexico

Atlantic and Gulf Menhaden Fishery

TARGET SPECIES: The U.S. menhaden fishery is the largest fishery in the United States in terms of volume and value. Menhaden are used primarily for the production of meal, oil and solubles, with small quantities used for bait and canned pet foods. In 1985, menhaden accounted for 85% of the fish meal and scrap produced in the United States, more than 95% of the fish solubles, 98% of the fish oils and 49% of the nonedible exports of fish products produced in the United States (U.S. Dept. Commerce 1986). Recently the Japanese have developed ways to manufacture menhaden into a human food item called "surimi," but its present commercial use is minimal.

Landings of menhaden in 1985 were 2.7 billion pounds valued at $100.7 million which contributed over 43% of all finfish by volume landed by U.S. commercial fishermen. The Atlantic menhaden supports a large fishery from Canada to the northern border of Florida but the Gulf of Mexico menhaden fishery now accounts for two-thirds of the menhaden catch in the United States (Doody 1981).

Atlantic coast landings of menhaden in 1985 were 791.6 million pounds valued at $33.2 million most of which was taken within three miles of shore. Landings increased by 67.4 million pounds in the Atlantic states as compared to 1984. In the Gulf, 1.9 billion pounds of menhaden valued at $67.5 million were landed, a decrease of 219 million pounds as compared to 1984 Gulf landings. Again, most (92%) of all menhaden landed in Gulf states were taken within three miles of shore.

GEAR: Large-scale commercial fisheries for menhaden are conducted with purse seines which are large "curtain-type" nets hung between surface floats with weights along the base. Two boats, called purse boats, drop the net in a circle and once a school of fish is enclosed a heavy weight is attached to a purse line and dropped overboard. The purse line is then pulled in, causing the bottom of the seine to close like a purse. Today spotter planes are used to sight schools of menhaden. Pumps are used to suck fish from the nets through hoses to the ship's hold where they are stored in refrigerated water. An average catch of menhaden numbers between 50,000 and 100,000 fish (Doody 1981), however bigger sets involving over a million fish have been observed.

LEVEL OF EFFORT: The most recent official information available on the U.S. menhaden fishing fleet by state is for 1977. At that time, 139 purse seine vessels were in operation with 12 vessels in New England, 10 in New Jersey, 33 in Virginia, 20 in North Carolina, and 78 operating out of Mississippi and Louisiana. A total of 2,140 fishermen were employed in this fishery (U.S. Dept. Commerce 1984). In 1983, 122 purse seine vessels were in operation with 41 vessels active in the menhaden purse seine fishery in the Atlantic and 81 operated in the Gulf of Mexico. Throughout the 1983 fishing season these vessels set their nets over 100,000 times (U.S. Dept. Commerce 1985).

INCIDENTAL TAKE/ENTANGLEMENT: In 1984 the National Fish Meal and Oil Association, which represents eight to ten companies that harvest, process and market products from menhaden fisheries, received a Small Take Letter of Exemption from the National Marine Fisheries Service allowing permit holders to capture certain species of non-depleted marine mammals incidental to normal fishing operations in North Atlantic and Gulf menhaden fisheries. The permit is valid until December 31, 1988.

Under this Small Take Letter of Exemption a total of 33 marine mammals may be legally taken each year by both North Atlantic and Gulf fisheries combined. The species restrictions include 10 bottlenose dolphins, 5 harbor porpoises, 7 pygmy sperm whales, 7 dwarf pygmy sperm whales and 4 minke whales. The number of these species permitted in each region is given below.

Permitted Number of Animals Incidentally Taken

Species	North Atlantic	Gulf
Bottlenose dolphin	5	5
Harbor porpoise	5	0
Pygmy sperm whale	5	2
Dwarf sperm whale	2	5
Minke whale	2	2
Total	19	14

Each fisherman registered under the Small Take Letter of Exemption must maintain a log of all cases where marine mammals are taken including information on the location, time and date of the event, the sex, number, species and condition of the animals involved and the circumstances that led to the incident. The National Fish Meal and Oil Association must report all these records of incidental take to the National Fisheries Institute in Washington, D.C., a trade organization representing about 1,250 fishing companies and other fishing interests. The National Fisheries Institute, in turn, must submit an annual report on the incidental takes by the menhaden fishery under the Small Take Letter of Exemption to NMFS.

In 1984, the National Fish Meal and Oil Association reported that no marine mammals were taken under the Small Take Letter of Exemption for that year (Hollingshead pers. comm.). As opposed to the New England Gill Netters' Small Take Letter of Exemption process which resulted in the submission of a 52-page report documenting the incidental taking of marine mammals during gill net operations in 1984, the National Fisheries Institute submitted a one page letter reporting that no incidental taking had occurred. According to NMFS (Hollingshead pers. comm.) for 1985 there was one report of an observation of two bottlenose dolphins taken in a menhaden net. This incident, however, was reported by beach combers who observed the taking. It was not reported in the logbook of the fisherman involved, but the incident was recorded on a reporting form submitted by the National Fisheries Institute.

It has been suggested that unless fishermen are seen capturing something, they will not report it (Hollingshead pers. comm.). Fishermen feel that if they report incidental takes they will be contributing to the total count under their fisheries quota and there is a fear that if that quota is reached they will no longer be permitted to fish. Therefore, it is just as easy not to report any incidental takes.

Available information indicates that more animals are taken in the menhaden fishery than are being reported. In fact, many dolphins may die each year in menhaden purse seines (Reynolds 1985). Based on surveys distributed to individuals knowledgeable about incidental taking in fishing operations in the southeastern United States, the number of bottlenose dolphins that drown each year in purse seines include: 10-15 in North Carolina; 1-10 in Mississippi; 1-10 in Louisiana and occasional animals in Texas and along the west coast of Florida. A detailed list of reports on marine mammal incidental takes in the menhaden fishery is given in Table 12. Others have noted that sea turtles are often caught in menhaden purse seines as well but documentation on these reports is not available (Crouse 1982).

It has been suggested that the menhaden Small Take Letter of Exemption reporting system should be modified to be more similar to that of the New England groundfish gill netters. Under this reporting system marine mammals taken under the permit are brought by gill netters to personnel at the University of Orono, Maine, for necropsy, morphological studies, analysis of gut contents and other studies. In addition, scientific observers are permitted to observe fishing activities (Reynolds 1985).

Large numbers of dolphins are found off Mississippi and Louisiana where most menhaden are landed. In addition, off North Carolina where the largest catch of menhaden in the south Atlantic is taken, the size of the dolphin population in this area is not fully known. It is therefore important that the impact of this fishery be properly addressed through a more closely monitored reporting system (Reynolds 1985).

Table 12. Marine mammals incidentally taken in the U.S. menhaden fishery

Date	Species	Location	Number	Condition	Remarks	Source*
8/12/85	bottlenose dolphin	Sandbridge VA	3+	alive	only head found washed up; 3-6 caught incidentally according to witnesses and fishermen	M. Hare
May to Nov. yearly	bottlenose dolphin	Cape Lookout to Holden Beach, NC	10-15	dead	apparent drowning in menhaden purse seines	
3/26/85	bottlenose dolphin	Tampa Bay FL	1	dead	apparently shot while in net, thought to be a menhaden net due to menhaden in esophagus. Rope marks	
1980-84	bottlenose dolphin	Mobile Bay and Mississippi Sound, MS	25+ over 4 years	dead	drowned in gill nets and purse seines. Menhaden purse seines account for 1-10 dolphins/yr.	
1980-84	bottlenose dolphin	Coastal LA	1-10	dead	drowned in purse seines ?	
1979-1983	bottlenose dolphin	Calhoun County, TX	2	dead	drowned in purse seines.	

Note: Source of information is Reynolds 1985, unless otherwise noted.

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Florida Crab Trap Fisheries

TARGET SPECIES: There are two major crab trap fisheries conducted in Florida—the blue crab and stone crab fisheries. Florida is essentially the sole producer of stone crabs within the United States. Stone crabs are only harvested for their claws. A fisherman may legally remove only one claw from a captured crab. Once the claw is removed the crab is returned to the water where it will regenerate the lost claw.

The most current official landings data for these fisheries are for 1977, when 19.3 million pounds of blue crabs were taken valued at $3.9 million. Stone crab landings were approximately 3.5 million pounds valued at $3.1 million. Preliminary data for 1985 indicate that landings have remained fairly stable throughout the years although prices have increased; 17.4 million pounds of blue crabs were landed valued at $4.8 million dollars and stone crab landings were 3.7 million pounds valued at $7.3 million dollars.

GEAR: Traps are the principal gear type used in these fisheries. Blue crab traps are typically two feet square made of 2 1/2 inch mesh galvanized or plastic coated wire with a heavy metal frame tied to the bottom for weight. The majority of stone crab traps measure 16x16x11 inches or 14x21x11 inches in length, width and height respectively and have been traditionally constructed of wooden lath although plastic traps are being used increasingly. Concrete is poured onto the bottom of a stone crab trap to add weight. Although blue and stone crab traps are designed to fish for the particular species, blue crab traps do catch stone crabs and vice versa.

For both fisheries, traps are set singlely or in lines. Each individual trap must be marked with an 8-inch diameter buoy at the surface that is attached to the trap by a nylon or polyethylene rope. The float enables the fisherman to locate the trap and pull it into the boat for baiting and removing the catch. Buoy ropes vary in length depending on the depth of water but are usually just long enough to reach the surface since excess line increases the chance of it being cut by a boat propeller. Traps remain in the water throughout the fishing season and fishermen tend traps regularly. Blue crab traps are generally checked every 48 to 72 hours. In general, traps that are set near shore and in inland waterways are tended more frequently than those set far offshore for stone crabs.

Blue crab fishing occur's year round but activity decreases during colder weather. Stone crab fishing season begins in October and extends through May.

AREA OF OPERATION: Florida's blue crab fishery is conducted entirely within coastal areas and inland waterways. The stone crab fishery on the east coast is conducted within coastal areas (within three miles), but on the the west coast it is concentrated in the Gulf of Mexico beyond three miles of the Florida shoreline.

Traditionally the fisheries on the west coast of Florida have produced most of the state's crab catch, especially for stone crabs. In 1985, practically all stone crabs (99.7%) and approximately 70% of all blue crabs were taken in the west coast fisheries.

LEVEL OF EFFORT: Florida's west coast stone crab trap fishery has been the most extensive in terms of number of fishermen and traps. The most recent information available on the level of effort in these fisheries is for 1977. At that time there were 204 fishermen engaged in the west coast stone crab trap fishery with 266,985 traps or 1,309 traps per fisherman. An additional 217 blue crab fishermen were reported fishing for blue crabs with 42,770 traps or roughly 200 traps per fisherman. On the east coast there were fewer fishermen engaged in these fisheries with fewer traps. In the stone crab trap fishery there were 29 fishermen with 3,470 traps or approximately 200 traps per fisherman. The number of blue crab fishermen was 109 with 12,125 traps or 111 traps per fisherman (U.S. Dept. Commerce 1984). However, the number of fishermen and traps, at least in the stone crab trap fishery, has increased in recent years (Gulf of Mexico Fishery Management Council 1981).

INCIDENTAL TAKE/ENTANGLEMENT: Crab trap float lines present a potential hazard to West Indian manatees, an endangered species, that forage along the bottom of shallow coastal waters in search of aquatic plants. Excess line between the floats and traps become entangled around manatee flippers causing serious injury or death. In fact, every year manatees are reported entangled in crab trap lines in Florida.

During a ten-year period from 1974-1984, over 30 manatees have been reported entangled in crab trap lines or with scars indicative of previous entanglements (Table 13). One manatee had ingested a rope. Of these 30 incidents, two of the animals died, six were released and the fate of the remaining individuals was unknown. Even for those animals that survived, some were either badly scarred or had a flipper become necrotic or amputated because it was so badly injured.

All of these animals have been observed within inland waterways and are presumed to have encountered blue crab traps since stone crab traps are typically set further offshore. Most of these incidents have occurred within manatee sanctuaries established by the state including Lee County-Orange Caloosahatchee Area, Citrus County-Kings Bay Area and especially Brevard County in the area of Merritt Island National Wildlife Refuge. Merritt Island National Wildlfife Refuge has had the greatest number of occurrences.

Commercial fishermen including crabbers are required to obtain a Special Use Permit each year in order to fish within Indian River, Banana River and other areas within Merritt Island National Wildlife Refuge. Permits are renewed each year beginning in October. In 1985, 150 permits were issued. As of October 1986, 75 commercial permits had been issued (Douglas pers. comm.).

In 1980, the Merritt Island National Wildlife Refuge reviewed the problem of manatee entanglements in crab trap lines and proposed some solutions (Lee and Weintraub 1980). For one, it was suggested that slack in the rope between the buoy and the trap should be kept at a minimum. However, others have observed manatees "playing" with buoy line and indicated that they would probably become entangled in a taut line as easily as a loose one (Rathburn 1981). Another suggestion was to require crab trappers to use time release rings that would keep the float attached to the trap--with the line resting on the bottom. The ring would corrode after a predetermined time (1-7 days) and the float would then pop up. However, some have suggested that the loose line resting on the bottom may pose an even greater chance of entangling manatees. The use of PVC pipes around the lines has also been suggested which may be an inconvenience for fishermen in handling time. Others have suggested a possible solution may be that instead of setting traps singly, many traps could be strung on one line along the bottom buoyed at each end thereby decreasing the amount of floats needed. A final solution would be to eliminate crab trapping in the Refuge which would require an economic evaluation and associated public meetings.

Although the crab trap entanglement problem for manatees is not as severe as the problem of boat collisions, with a population of under 1,000 individuals estimated in Florida coastal waters the death of even a small number of manatees each year attributed to entanglement could be a serious problem and it appears to be increasing (Lee and Weintraub 1980).

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Table 13. Records of manatees entangled in fishing gear and debris in Florida. (Source: Possert pers. comm.).

Date	Location	Condition	Remarks
11/11/74	Cocoa	dead	rope around both flippers
4/16/76	Brevard County	released	entangled in crap trap line
?/26/77	?	?	monofilament
?/18/77	?	?	flipper-line
12/14/78	Brevard County	?	buoy and line attached to flipper
1/22/79	Brevard County	alive	deeply scarred left flipper (possibly same animal as 12/14/78)
1/29/79	Brevard	released	buoy and line on left flipper
1/30/79	Brevard County	alive	entangled in research buoy
4/17/79	Shell Harbor	dead	caught in hoop net
6/5/79	Indian River	?	entangled in float and line
8/6/79	Gainesville	alive	buoy line on tail
9/17/79	Lee County, Caloosahatchee River	dead	entangled in crab trap lines
6/26/80	Fort Meyers	alive	rope; crab trap
8/8/80	Fort Meyers, Caloosahatchee River	released	entangled in crab trap line
1/19/81	Crystal River	?	entangled with two buoys
2/12/81	Point Everglades	?	ingested rope
8/5/81	Satellite Beach	alive	monofilament fishing line around tail
8/7/81	Banana R.	alive	caught in crab trap
11/20/81	Caloosahatchee	freed	crab trap line and float

Table 13. (cont.) Records of manatees entangled in fishing gear and debris in Florida.

Date	Location	Condition	Remarks
4/12/82	Merritt Is.	alive	several types of rope & buoys around flipper; necrotic flipper fell off
5/4/82	Vero Beach	alive	entangled in diver's float
5/19/82	Merritt Is.	rescued	crap trap line around left flipper
6/30/82	Crystal River Citrus County	?	crap trap line around manatee
7/3/82	Ocala	?	crab trap; entangled with float
8/1/82	Flager County	?	cow with line and plastic jug attached
1/4/83	Kings Bay	?	crab trap line cut to bone
6/28/83	Indian River	?	crab trap & line around left flipper
7/5/83	Orange Park	?	net over body
7/21/83	Brevard County	?	crab trap line around flipper
8/19/83	Indian River	alive	crab trap - flipper amputated
5/12/84	Naples	?	line and buoy
5/13/84	Brevard County	rescued	line and float
1984	statewide	?	6 additional animals reported; location and status unknown

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Atlantic and Gulf Swordfish Fishery

TARGET SPECIES Swordfish are large migratory fish found worldwide. Commercial catches of swordfish are of importance primarily in temperate zones, and secondarily in tropical and sub-tropical zones. Compared to all the commercial finfish landed in the United States, swordfish bring the greatest price; in 1985 swordfish were valued at $2.77 per pound and an average fish may weigh 100 pounds or more.

In 1985, U.S. landings of swordfish were approximately 12.3 million pounds valued at $33.2 million. Of this, 6.6 million pounds were taken in the Atlantic and Gulf of Mexico, with the remaining landed in California. The New England and the east coast of Florida swordfish fisheries accounted for 70 percent of the 1985 landings in the Atlantic with approximately 2.6 million pounds (40 percent) and 2 million pounds (30 percent) respectively. Landings in the Gulf of Mexico were 1.1 million pounds (17 percent). Swordfish landings in other areas for 1985 included 772 thousand pounds in the mid-Atlantic (12 percent), 78 thousand pounds in North Carolina, South Carolina, and Georgia and 16 thousand pounds in the Chesapeake states.

GEAR: Although swordfish have been taken commercially from the northwest Atlantic since the 19th century, until 1962 virtually all were caught with harpoons and fishing was confined between New York and Canada. Harpooning, however, is extremely limited by weather conditions, the size of swordfish found at the surface (normally only larger swordfish greater than 100 pounds are found at the surface), and the fact that swordfish come to the surface, or "fin," only in waters from New York northward.

With the introduction of longlines, swordfishing and associated fishing practices have undergone very rapid technical changes and catches have increased dramatically. A recent change from multifilament to monofilament main lines has made it possible to fish over 40 miles of longline at one time, with the line suspended horizontally from a series of floats. Hooks are being spaced increasingly further apart with often 10, and no more than 20 per mile set. A chemical light, typically a cyalume light stick, is attached to the line just above the bait to attract fish. A typical longline vessel in New England is 60-80 feet long and uses 15-40 mile longlines, with 400-2,000 hooks fished per night for 7-15 days. New England longline gear is generally set 40 feet below the surface with vertical hook lines extending an additional 20 feet from the mainline. A typical Florida vessel is 35-50 feet in length and uses 5-12 miles of longline with 100-400 hooks fished per night for 1-2 days. Longlines used by Florida fishermen are characteristically set 50 feet below the surface with hooks attached to vertical lines extending an additional 40-120 feet below (South Atlantic Fishery Management Council 1985b). Longline fishing for swordfish is typically conducted at night.

Most recently, drift gill nets have been introduced in the northeast Atlantic swordfish fishery patterned after those used in the shark fishery of California. The nets are made of 18-inch stretched mesh, 90 feet deep and approximately one mile long with one end attached to the boat to prevent the net from becoming tangled. Nets are set approximately 18 feet below the surface and are typically set at dusk and pulled at dawn. The time required to haul the gear varies from 1 to 3 hours. Generally, vessels harpoon during the day and use gill nets at night. The net cannot be fished safely when the wind speed is over 20 knots and the crew must often tend the net when wind and current conditions change. Drift gill net fishing has been described as an attractive alternative for the following reasons: it is used at night and therefore does not physically conflict with commercial harpoon and recreational rod and reel fisheries; it requires about 70% less fuel than daytime harpoon fisheries; and swordfish catch data indicate that gill nets may be more efficient than harpoons, especially during seasons of poor surface visibility (South Atlantic Fishery Management Council 1985b).

A Japanese longline fishery for tuna operating within the U.S. Fishery Conservation Zone (FCZ) incidentally captures billfish including swordfish. This fishery has existed in the Atlantic since 1956. Longlines used in this fishery are from 60 to over 80 miles in length, suspended horizontally from 32-98 feet below the surface with a series of floats. The branchlines suspended vertically from the mainline are 50-80 feet in length with a hook attached to the end (Witzell 1984). In contrast to the swordfish longline fishery which operates primarily at night, Japanese longlines are fished predominantly during the day with some night fishing.

AREA OF OPERATION: In the New England region commercial catches of swordfish are taken from continental shelf and slope waters, primarily from Georges Banks to offshore Gulf Stream waters in June through December. In the South Atlantic and Gulf of Mexico regions, swordfish are taken in continental shelf and slope waters of all bordering states primarily during winter and early spring. In southeast Florida the peak fishing season is spring through summer. In the Gulf, principal fishing areas are around the mouth of the Mississippi River and northwest of Key West, Florida in late winter and early spring.

The swordfish longline fishery will be closed for the first time this year (1986) within the U.S. 200-mile limit in certain areas during a two to three week period in early fall to minimize the catch of small swordfish which is generally greatest in the fall. However, this does not preclude longline vessels from fishing outside of the 200-mile limit during these closures. In New England, 83% of the 1985 swordfish landings were taken outside the 200-mile limit. In addition, during the fall closures the tuna season is at its peak. Therefore, daytime tuna fishing is permitted during closures providing an alternative fishery for swordfish longliners. While the number of fish caught by each longline set is not large, the value of a few fish is still very great.

LEVEL OF EFFORT: As of January 1985, 340 U.S. commercial swordfish vessels were operating in the northwest Atlantic and Gulf of Mexico. Although this number represents a decrease in number of vessels since the early 1980's, total effort is believed to have increased because many of the smaller vessels have dropped out of this fishery and those remaining are larger, make longer trips and use considerably more gear (South Atlantic Fishery Management Council 1985a). A total of 19,438 fishing days and 6.5 million hooks were set for swordfish in the Atlantic and Gulf of Mexico during the

1983 fishing season (South Atlantic Fishery Management Council 1985b).

The Japanese tuna longline fleet has recently decreased in effort in the FCZ. From 1977 to 1980 Japanese effort in the northwestern Atlantic increased from 15.7 million hooks to 31.4 million hooks. Until 1981 Japanese tuna longline vessels had operated from 2,000 to 5,000 days per year within the U.S. 200-mile limit. However, in 1982 they imposed voluntary regulatory measures for their operations in the Gulf of Mexico and since 1983 they have not fished in this area. Also, in 1982 foreign longlines were prohibited from fishing in the Atlantic FCZ out to 100 miles north of Cape Lookout, North Carolina to the U.S./Canada boundary between June 1 through November 3. In 1983, foreign longlines were also restricted from fishing within 100 miles of Key West, Florida to Cape Lookout from June 1 to September 30. With the main fishing season closed for blue fin tuna closed, the value of the U.S. 200-mile zone as a fishing ground to the Japanese sharply declined. In 1983, five to six Japanese vessels operated in U.S. waters for a total of 400 vessel days (South Atlantic Fishery Management Council 1985a).

Drift gill nets for swordfish have been used by two boats in New England since 1980 with two to five boats engaged in drift gill net fishing throughout the region at various times (South Atlantic Fishery Management Council 1985a).

INCIDENTAL TAKE/ENTANGLEMENT: In 1985, the South Atlantic Fishery Management Council reported in its Swordfish Fishery Management Plan that "marine mammals and sea turtles are caught very infrequently in the longline fishery." This conclusion was based on information from 1979 of the incidental capture of marine mammals and sea turtles reported by U.S. observers aboard Japanese tuna longline vessels. Observers aboard Japanese vessels operating in the Gulf of Mexico reported 12 sea turtles (2 leatherback turtles and 10 unidentified turtles) and no marine mammals incidentally taken in 199 sets using 451,902 hooks with a turtle mortality rate of 10-50%. In the Atlantic, observer data for 1979 reported 17 turtles (9 loggerhead turtles and 8 unidentified turtles) in addition to 1 bottlenose dolphin, 2 false killer whales and 2 unidentified dolphins during 295 sets with a total of 663,551 hooks. In 1980, 10 turtles were reported caught. The mortality rate for turtles was 37.5% and for marine mammals ranged from 0% for porpoises to 50% (one of the two false killer whales caught).

Witzell (1979) calculated that the incidental catch in the Atlantic U.S. Fishery Conservation Zone by the Japanese tuna longline fleet during 1978-81 was 330 turtles based on observer files and the total effort of the fishing fleet during this period. The estimated fishing effort during this period was 28,360,191 hooks. A total of 126 turtles were assumed captured in the Atlantic (off Long Island to North Carolina) and 204 in the Gulf (primarily off the coasts of Mississippi, Louisiana and Texas); there is a much greater chance of capturing turtles on longlines in the Gulf since overall fishing effort was lower in this area (approximately 1.7 million hooks) as compared to the Atlantic (approximately 3.6 million hooks). The greatest number of turtles were reported captured during the months of January-March in the Gulf and September through January in the Atlantic. This was also the time of greatest fishing effort in this fishery. Most of the identified turtles reported captured were leatherbacks. Others that were not identified were assumed to be either green, loggerhead or Kemp's ridley turtles.

The turtles incidentally captured were either hooked in the mouth, hooked in the flipper-shoulder area or entangled in the branchline attached to the mainline. Loggerhead turtles are more likely to eat the bait and become hooked in this way as compared to other species. Leatherbacks are likely to become hooked in the flipper-shoulder area or entangled in the branchline due to their large flipper span. Seven percent of the turtles observed captured died in longline operations in the Gulf whereas 30% died in incidental captures in the Atlantic. This difference in mortality was possibly attributed to the different fishing strategies used in these areas or that the Atlantic tuna longline fishery is conducted primarily during the winter and captured animals may die from thermal shock.

In 1982, a vessel out of New Bedford Harbor Massachusetts, was observed fishing for swordfish in the Grand Banks area off Newfoundland. The boat fished one longline each night for a period of eight days using 300-500 hooks each time. A total of 91 swordfish, and 34 sharks, rays and fish were caught. Sea turtles were observed incidentally captured in three of the eight longline sets and an additional turtle was observed floating next to one of the longline floats.

In view of the above information it would appear that the level of incidental take in the expanding swordfish longline fishery should be monitored in order to determine the frequency of incidental takes. At present, no such monitoring system has been established since this is a domestic fishery that does not require an observer program. However, it seems inappropriate to base a conclusion of incidental take in this fishery on the Japanese fishery that uses longlines differently. For instance, Japanese tuna longline operations are conducted primarily during the day whereas swordfish longlines are fished at night. Therefore the visual detection of longlines by marine mammals and sea turtles may differ. Japanese longlines are also set within a greater depth range than those for swordfish. The use of chemical lights to attract swordfish to longline bait may also attract marine mammals and sea turtles, especially those that feed on jellyfish and other prey that are bioluminescent. In addition, fishermen have indicated that prime areas for swordfishing in New England is in warm, oceanic water (blue water) which usually sweeps over the Grand Bank in the summer in the form of a warm water eddy or a meandering gulf stream (South Atlantic Fishery Mangement Council 1985a). Large numbers of Kemp's ridley turtles have been thought to be concentrated in similar warm water masses off of Long Island (Meylen and Sadove 1986).

With the introduction of drift gill nets in this fishery the problem of incidental take will probably increase based on the history of incidental takes of marine mammals in the California drift gill net fishery after which the swordfish gear was patterned. Although there are very few data on the drift gill net fishery in terms of both swordfish catch as well as incidental catch, a pilot whale was reported caught in a drift gill net in the vicinity of Georges Banks in 1980. In 1985, the South Atlantic Fishery Management Council applied to the National Marine Fisheries Service for a Small Take Letter of Exemption to incidentally capture marine mammals in the swordfish drift gill net fishery off the southeast Atlantic coast. The application will not be accepted until the fishery develops a sufficient biological observer program (Hollingshead pers. comm.). One fisherman, whose comments were included in the Swordfish Fishery Management Plan (1985a) stated that he had caught porpoises and turtles with both longlines and gill nets. In addition, these large nets could become lost and have the potential to catch fish, marine mammals, sea turtles, and birds indefinitely.

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Atlantic and Gulf Shrimp Fishery

TARGET SPECIES: Shrimp support the most valuable fishery in the United States. The principal U.S. shrimp fishery extends along the southeastern Atlantic and Gulf of Mexico from North Carolina to Texas. The principal species of shrimp taken are brown, white and pink shrimps.

During the period of 1980 to 1985 the U.S. shrimp catch averaged 305 million pounds. In 1985, 331 million pounds of shrimp were landed in the U.S. valued at $472 million. Eighty-two percent of this catch was taken in the South Atlantic and Gulf of Mexico. The commercial fishery in the Gulf accounts for most of the U.S. catch. In 1985, 262.9 million pounds of shrimp were landed in the Gulf of Mexico valued at $398.7 million. The South Atlantic fishery landed 27.9 million pounds valued at $54.4. The states of Louisiana and Texas bring in more than half of the total U.S. shrimp catch. In 1985, Louisiana had the greatest catch with 114.2 million pounds, followed by Texas with 84 million pounds, Florida with 28 million pounds, Alabama with 20.1 million pounds, and Mississippi with 16.5 million pounds. In the Southeast Atlantic, North Carolina has been the leading state with approximately 11.7 million pounds in 1985, followed by Georgia with 7.8 million pounds, and South Carolina with 3.4 million pounds.

GEAR: Shrimp are harvested by means of trawls. In general a fisherman will pull two to four trawl nets at one time. Trawl nets may be 15 feet high and over 40 feet across. These nets are pulled a few inches above the bottom using small lines, "tickler chains," which cause the shrimp to jump to a level in line with the trawl.

AREA OF OPERATION: The brown shrimp, which is the species most commonly caught in this fishery, typically inhabits waters less than 180 feet in depth in the Gulf of Mexico and primarily along the coasts of Mississippi, Louisiana and Texas. The season for catching this species in the Gulf begins in May with a June and July peak and declines toward a low in April. In the South Atlantic brown shrimp are taken beginning in June or July. The white shrimp is the second most common species taken in this fishery. In general this species is found in shallower waters than the brown shrimp being found in waters less than 90 feet in depth. The season for this species peaks in May and once again in late summer and early fall. The highest concentrations of white shrimp are taken west of Mississippi to Freeport, Texas. In the South Atlantic, the white shrimp season from South Carolina to Florida begins around August and lasts through December. Pink shrimp are taken in lesser quantities along the Gulf coast and are concentrated off southeastern Florida in waters less than 150 feet in depth. The season for pink shrimp generally peaks between May and October.

The major area of operation of the shrimp fishery varies for each state. In Texas, where the majority of the U.S. commercial harvest is taken, shrimp fishermen have concentrated their efforts in waters three or more miles from shore. In recent years 75% of the Texas shrimp landings were taken in this area. Louisiana shrimp fishermen, on the other hand, take most shrimp from waters within three miles of the coastline. North and South Carolina fishermen also concentrate shrimp fishing activities within three miles of shore whereas Georgia and Florida fisheries are primarily conducted in offshore waters.

LEVEL OF EFFORT: In 1983, the southeastern shrimp fishery was conducted by an estimated 6,405 vessels and 7,653 boats. Of these, 4,999 vessels and 6,439 boats fished in the Gulf of Mexico. In addition, thousands of noncommercial shrimp boats also fish for shrimp in this area.

INCIDENTAL TAKE/ENTANGLEMENT: Each year the U.S. shrimp fishery incidentally catches and drowns thousands of sea turtles in the southeast Atlantic and Gulf of Mexico. Shrimp fishermen interviewed in the mid-1970's estimated that they caught from two to more than 50 sea turtles each season. Estimates of mortality rates were from about 8 to 48%. These estimates, however, are conservative.

In 1986, the National Marine Fisheries Service estimated that almost 48,000 sea turtles are incidentally taken in shrimp trawls every year. Of these, approximatley 34,000 are taken in the South Atlantic fishery and 14,000 are caught in the Gulf. Of these, more than 7,000 of the turtles caught in the South Atlantic fishery and 4,000 in the Gulf drown as a result of the incident. This estimate includes loggerheads, greens, leatherbacks, Kemp's ridleys and hawksbills, all of which are endangered or threatened (See Table 14).

When a turtle gets in the path of a trawl it generally tries to outswim it instead of swimming to the side and out of the net's path. Eventually, as the turtle tires, it is caught. If the trawl is not pulled out of the water shortly thereafter the turtle will drown. Even if a turtle survives an initial capture and is released by a fisherman it may not survive a subsequent capture if it occurs soon after the first.

Most of the turtles taken in shrimp nets are juvenile loggerhead turtles. Kemp's ridleys, which are critically endangered with perhaps fewer than 500 adult females remaining, are taken in both inshore and offshore shrimp fishing operations. Juvenile Kemp's ridley turtles are primarily caught in shallow water where they feed on blue crabs--a major prey item. Adults are taken in all areas during their migration between feeding areas and nesting areas in Mexico.

In 1981, the Gulf of Mexico Fishery Management Council, in a management plan for the shrimp fishery in the Gulf of Mexico, addressed the issue of incidental take of sea turtles in the shrimp fishery and proposed that an education program be developed to inform shrimpers of the need for sea turtle conservation and to teach them techniques to resuscitate turtles. The plan also encouraged research to develop gear that would reduce incidental takes.

Between 1978 and 1984 the National Marine Fisheries Service spent $3.4 million on a research program to develop such gear that would reduce .pa incidental capture of sea turtles. The result was the development of the Turtle Excluder Device (TED) later named the Trawling Efficiency Device because it also afforded the fishermen increased quality and value of shrimp catches by reducing bycatches of other fish species that can damage shrimp in the net.

The TED is a cage-like device that is placed in front of the bag or codend of a trawl. When large objects, including turtles, encounter the bars on the TED, which slant at a 45-degree angle, they are forced up through a trap door and subsequently out of the net. A funnel of webbing in front of the bars accelerates water flow past the bars and small objects such as shrimp pass through into the codend. Another set of bars at the back of the TED tend to force unwanted catches of fish forward where fish encounter panels of webbing that lead the fish out of the sides of the trawl. The TED weighs approximately 37 pounds and costs $400 for materials and labor.

The TED has been shown to be beneficial to shrimp fishermen in several ways. In the Gulf, shrimp fishermen catch approximately 1.5 bilion pounds of finfish, which are discarded overboard. Tests show that the TED reduces the bycatch of small fish by 50% during the night and 70% when used during the day. The TED therefore saves the fisherman fuel costs by reducing the weight and drag of the net, and time spent on sorting shrimp from the catch.

If all shrimp fishermen in the South Atlantic and Gulf of Mexico used the TED a major threat to sea turtles would be eliminated. Studies have indicated that only 3% of the 48,000 sea turtles estimated to be caught in the shrimp fishery each year would be caught if the TED were universally used.

However, despite the proven qualities of the TED in eliminating bycatch, enhancing shrimp catch, and preventing sea turtle drownings, less that 1 percent of the U.S. shrimp fleet are using the TED at any time. Yet as a result of programs to promote its use most fishermen know about the TED. Therefore, it appears that the TED will be used only if state and federal regulations mandate its use.

Ironically, since 1982 the Indonesian government has required that Japanese shrimp trawlers fishing in Indonesian waters use TEDs and as a result more than 1,000 are now being used. In response to numerous requests, the National Marine Fisheries Service has also provided field demonstrations of the TED to several other countries including Mexico, Panama, Honduras and Australia.

Added to this large incidental capture of sea turtles, the shrimp fishery in the southeastern United States also is suspected of killing several bottlenose dolphins every year. Reports of dolphins that have been known or are thought to have drowned in shrimps nets have come from North Carolina to Texas. In North Carolina, South Carolina, Georgia, and Alabama one to two dolphins have been reported killed (Reynolds 1985, Hare pers. comm.). In Florida, Mississippi, Lousiana and Texas the problem may be more severe with reports of many animals killed each year (Reynolds 1985).

The total magnitude of bottlenose dolphin mortality has not been estimated. A potentially large problem, however, may exist for certain local groups of dolphins (Reynolds 1985). The large shrimp fishery off Texas, Louisiana and western Florida may threaten large populations of dolphins in this area.

Table 14. Incidental take and mortality of sea turtles in the U.S. shrimp fishery for 1986 (Henwood and Stuntz 1986).

	CAPTURE			MORTALITY		
Species	So.Atl.	Gulf	Total	So.Atl.	Gulf	Total
Loggerhead	32,120	10,789	42,909	6,745	3,129	9,874
Kemp's Ridley	1,268	1,727	2,994	266	501	767
Green	493	432	925	104	125	229
Hawksbill	70	432	502	15	125	140
Leatherback	211	432	643	44	125	169
TOTAL	34,162	13,882	47,973	7,174	4,005	11,179

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COMMERCIAL FISHERIES OF THE PACIFIC OCEAN

Fisheries of California

Gill Net Fisheries

TARGET SPECIES: Of all California's fisheries, the gill net fisheries have expanded most rapidly and are the most diverse in terms of species harvested. Principal species taken by California's gill net fisheries include shark, California halibut, white seabass, rockfish, white croaker, California barracuda, Pacific bonito, flyingfish and inshore aggregate species including jacksmelt, Pacific pompano, opaleye, halfmoon, surfperches and miscellaneous flatfish (Miller et al. 1983).

The primary target species for the gill net fishery in central California are white croaker, sharks, halibut, surfperch, rockfish and miscellaneous flatfish. In southern California there is a much more diverse assemblage of gill net fisheries, but these fisheries are also more specialized in terms of target species. In recent years much of the gill net effort in southern California has been expended on the shark and halibut fisheries. Seasonal fisheries in southern California include those for species entering in summer and fall such as white seabass, California barracuda, Pacific bonito and flyingfish (Miller et al. 1983).

GEAR: Gill net fisheries are conducted with a variety of net types including set and drift gill nets as well as trammel nets. Legally any gill net with vertical slack is considered a trammel net but a true trammel net is a type of gill net used for entrapping species that are difficult to catch in a regular gill net. Trammel nets consist of two or more layers of either multifilament nylon or monofilament line with a loosely hung inner panel of 8-inch mesh and taut outer panels of 24 to 32 inch stretched mesh. Fish that encounter trammel nets swim through the larger mesh panel, push against the 8-inch mesh and thus become entrapped in a pocket. In some cases a fisherman may use more than one type of net in a single set such as using trammel net for halibut and gill net for shark. Moreover, most fishermen have two or three different kinds of net to be used during different seasons as species appear.

The type of net used in California's gill net fisheries varies according to target species, location, season and state and local regulations. California's gill net regulations are complex, varying between fisheries and areas of the coast. In general, all gill and trammel nets used in California require a permit.

AREA OF OPERATION: Gill and trammel have been used along the entire California coast, from Baja to Pt. Reyes. However, in recent years several locations have been entirely closed to gill net fisheries, and others have depth restrictions that have been imposed to protect marine mammals and seabirds. The most significant restrictions have been on the halibut and white croaker fisheries.

The first emergency closures to 10 fathoms were instituted in 1982, to protect seabirds in Monterey Bay. That year it was discovered that this closure shifted the fishery and concentrated the nets in slightly deeper waters where sea otters then were severely affected, and emergency closures were implemented. By 1985, the Legislature had instituted permanent closures to gill and trammel net fishing in waters less than 15 fathoms in the entire sea otter range.

Since then, closures have been extended to 10, 15, and in some areas, 20 fathoms to protect sea otters as well as other species, particularly common murres and harbor porpoise. North of the Sonoma-Mendocino County line, no gill or trammel net fishing is permitted for the purpose of protecting salmon stocks. Currently, more than 200 miles of central California coastline are closed to gill and trammel nets within the 15 fathom curve. The question of further closures, or extensions of existing closures, has been in flux since the spring of 1986, with various proposals for areas from Point Reyes south to Monterey Bay. Legislation has been proposed to extend closures along the central California coast to provide greater protection for harbor porpoises and seabirds.

LEVEL OF EFFORT: In 1981 there were 274 fishermen who received set gill net permits with an additional 78 drift gill net fishermen. At that time the most common target species listed by gill net fishermen were sharks followed by halibut and white seabass (Miller et al. 1983). Since then, the effort has greatly increased. At present there are approximately 900 general gill net permits (Hall 1986).

INCIDENTAL TAKE/ENTANGLEMENT: For all gill net fisheries conducted in California a minimum of 100 sea otters, 1,000 California sea lions, 100 harbor seals and possibly up to 25 elephant seals, 30 pilot whales and an unknown number of gray, humpback and finback whales drown each year in gill and trammel nets statewide (Miller et al. 1983). In addition, as many as 300 harbor porpoise are taken in the halibut gill net fishery in central California alone (Hanan and Diamond n.d.). Autopsies of dead marine mammals at Point Reyes National Seashore indicated that for over 50% of all carcasses on the beach between 1982-1984, the cause of death was a gill net (Deiter 1984; as cited Hoff 1985).

In 1983, an estimated 25,000 to 30,000 seabirds were taken in gill nets in central California (Wild pers. comm.). In 1984 and 1985 between 6,000 and 8,000 common murres were entangled and drowned each year. (Wild pers. comm.). Similar numbers are expected to be taken during 1986.

For many of these species the level of incidental take is correlated with fishing effort. For seabirds, and in particular the common murre and pigeon guillemot, peak fishing activity also coincides with the breeding season of these birds (Wild 1985). Consequently, incidental take of these birds in gill nets may be adversely affecting breeding colonies.

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Some species are particularly susceptible to entanglement because of their dependence on coastal habitats. This is particularly true of the California sea otter. In addition, during the southern migration of gray whales, 94% of the California stock pass within 1.6 km of Monterey-Point Sur area of central California (Rice et al. 1984). Peak levels of incidental take of gray whales coincide with the migration of whales. From 1980 to 1985, 33 whales were reported entangled in gill nets, most of these reports occurring during the period from November through March (Table 15).

Since most reports do not specify the type of fishery involved it is difficult to determine which fishery is having the greatest impact on migrating whales. But many of these entanglements have been reported in the area from Santa Barbara Channel to the Mexican border which is a major area for shark drift gill net activity. Following is a description of each of the major gill net fisheries of California.

Table 15. Whales reported entangled in gill nets in California, 1980-1985.

Date	Species	Condition	Remarks	Location
11/01/80	pilot	dead	drift gill net	Laguna Beach
11/01/80	pilot	dead	drift gill net	Laguna Beach
01/02/81	gray	dead	gill net	Coronado
06/01/81	finback	dead	drift gill net	?
03/01/82	gray	released	drift gill net	?
03/01/82	cetacean sp.	dead	drift gill net	?
03/23/82	gray	dead	gill net	1 mile north Rincon Point
05/01/82	cetacean sp.	dead	drift gill net	?
11/05/82	gray	dead	gill net	Santa Monica Bay
12/09/83	gray	dead	gill net	Ranchos Palos Verde
02/18/84	gray	released	gill net	Ranchos Palos Verde
03/21/84	gray	dead	gill net	Bolsa Chica State Beach
05/04/84	gray	dead	gill net	Cayucos, San Luis Obispo
07/09/84	humpback	released	gill net	Dana Point
09/01/84	minke	dead	drift gill net	?
12/27/84	humpback	dead	gill net	Santa Barbara Channel

Table 15. (con't.) Whales reported entangled in gill nets in California, 1980-1985.

Date	Species	Condition	Remarks	Location	
12/27/84	humpback	dead	gill net	Santa Barbara Channel	
01/04/85	gray	dead	gill net	13 miles off Dana Point	
01/14/85	gray	dead	gill net	Santa Cruz Island	
01/17/85	cetacean sp.	unknown	gill net	San Diego	
01/27/85	gray	dead	fishing line	Oceanside	Source: M. Hare
01/28/85	gray	released	gill net	Santa Cruz Island	
02/07/85	gray	alive	gill net	Point Hueneme	
02/11/85	gray	dead	gill net	Minuteman Beach Vandenburg AFB	
02/21/85	gray	alive	gill net	5 miles off east end of Anacapa	
02/23/85	gray	released	gill net	Bolsa Chica State Beach	
03/31/85	gray	alive	gill net	Catalina Island	
03/31/85	gray	dead	gill net	1/4 mile off Oxnard Breakwater	
04/04/85	gray	dead	gill net	Point Loma	
04/21/85	gray	dead	gill net	Dulah, Ventura Co.	Source: M. Hare
04/26/85	gray	released	gill net	Coronado Islands	
07/18/85	gray	dead	gill net	Sunset Beach	

Source: Carl Nettleton, Executive Director, Pacific Region National Coalition for Marine Conservation, San Diego, CA (unpublished data), except where otherwise noted.

Shark Gill Net Fishery

TARGET SPECIES: The most commonly targeted species in the California shark fishery are the thresher and bonito sharks. Other species taken include the soupfin, bigeye thresher and blue sharks.

California shark landings in 1985 were 3.4 million pounds valued at $2.9 million with the majority of landings taken 3 miles or more from shore (National Marine Fisheries Service, Office of Data and Statistics, unpublished data).

GEAR: Drift nets are typically made of nylon mesh of between 6.5 to 18 inches with 14 inches being most common. Nets range in size from 1200 to 6,000 feet in length, 18 to 78 feet in depth and are generally set 12 to 18 feet below the surface (Miller et al. 1983).

AREA OF OPERATION: The shark drift gill net fishery extends over the entire southern California Bight from Point Conception to Baja and to the offshore Tanner and Cortez banks. Fishing effort within this range is concentrated in areas off Laguna Beach, between San Diego and San Clemente Islands, off Pt. Dume and near Santa Catalina Island, while very little fishing is conducted near San Miguel and San Nicholas Islands. Fishing is conducted year round but fishing effort is low during the months of January through March (Miller et al. 1983).

LEVEL OF EFFORT: Between 1979-1983, 167 fishermen received drift gill net permits (Miller et al. 1983). There are now more than 230 drift gill net permits in the state (Hall 1986). During any night of the peak shark fishing season more than 100 miles of drift gill net may be set off California. Four years after its inception in 1977, shark drift gill net fishery landings tripled; in 1980, 3.28 million pounds of shark were taken in this fishery. In 1979, larger-meshed nets were introduced in this fishery to avoid the capture of unwanted fish. This large mesh netting also posed an additional advantage in that it allowed for the incidental capture of highly valued swordfish. In fact, part of the reason why fishing effort is concentrated in Laguna Beach and San Diego areas is that these areas also offer a high probability of swordfish catch (Miller et al. 1983).

As swordfish catches increased, however, lobbying and political pressure brought by sport fishing and harpoon associations competing for swordfish resulted in legislation aimed at regulating this fishery. Under this legislation, three basic controls on gill net fishermen were established. One regulation that pertains to all California gill net fishermen requires that all gill netters entering the fishery must pass a proficiency test before receiving a permit. In addition, for most gill net fisheries, those receiving permits must submit a log book of all activities (Miller et al. 1983). Although this is required by law, there is some degree of non-compliance in log book recordings (Hanan and Diamond n.d.).

Another restriction connected to this bill which is directly applicable to the drift net fishery is a quota system that restricts the incidental catch of swordfish in the shark fishery. An additional measure of the bill allows California Department of Fish and Game (DFG) personnel to observe fishing operations aboard vessels using drift gill nets (Miller et al. 1983).

INCIDENTAL TAKE/ENTANGLEMENT: Marine mammal interactions with the shark drift gill net fishery have been assessed by the California Department of Fish and Game (Miller et al. 1983). Often entanglements are not reported in log books maintained by fishermen but when interviewed by DFG personnel fishermen report taking California sea lions, gray whales and other marine mammals in their nets thus indicating the non-compliance of fishermen in reporting entanglement.

At-sea observations by DFG personnel recorded a value of 0.28 sea lions per net per day. Based on the total fishing effort calculated for this fishery, a minimum of 678 California sea lions were drowned in shark drift gill nets during September 1980 to September 1981. Based on further calculations done by Miller et al. (1983) which included information on set net fisheries for shark the best approximation of mortality of California sea lions is between 700 and 1,200 animals per year. As many as 15 sea lions have been recorded in a single net. In addition, this fishery is estimated to take as many as 30 pilot whales per year and an unknown number of gray and finback whales. However, once a whale becomes entangled it does not necessarily perish immediately but can travel long distances until it may eventually tire or starve. One young gray whale was found entangled in a gill net in the Palifax River of Willapa Bay, Washington but before it could be rescued it became caught among the pilings of a bridge and drowned (Beach 1981). Scientists determined that it had been entangled in 30 feet of black nylon gill net similar to that used in the shark fishery near the Channel Islands off California.

Bottom set gill nets are also used to catch shark in the area south of Bodega Bay and a smaller shark fishery in central California uses only set gill nets. While estimates of marine mammal mortality in this fishery were not available, new fishing techniques in the set net fishery may lead to a greater frequency of sea lion entanglements (Miller et al. 1983).

California Halibut Gill and Trammel Net Fisheries

TARGET SPECIES: The California halibut is a kind of flounder which inhabits bays and estuaries along the central and southern California coast. In spring halibut migrate from relatively deep offshore waters to spawn in shallow coastal waters at depths ranging between 5 to 18 meters. Although the demand for halibut in California is high, the abundance and availability of this species is relatively low. Therefore it supports a small but lucrative fishery. California halibut landings in 1984 were 1.1 million pounds valued at $1.9 million (Stadler 1985).

GEAR: The principal gear types used in this fishery are gill and trammel nets. Gill nets are constructed of 8-inch mesh net and are suspended with either no vertical slack or with a line between the lead (bottom) and cork (surface) lines to cause vertical slack. Trammel nets have inner panels of 8-inch mesh and nets used in central California typically have 28-inch mesh outer panels. California halibut is the major target species for trammel nets but most other species also become entangled. Both gill and trammel nets in this fishery range from 8 to 14 feet in height and 150 to 400 fathoms (900 to 2400 feet) in length (Wild 1983).

AREA OF OPERATION: Fisheries for California halibut are conducted year round with major areas of operation in central and southern California. The central California fishery encompasses three principal areas: the San Francisco Bay area from Bodega Bay to Half Moon Bay; the Monterey Bay area from Half Moon Bay to Point Sur; and the Morro Bay area from Point Sur to Point Arguello. In southern California halibut gill and trammel net fishing is conducted in the vicinity of Santa Barbara and between Newport and San Diego (Miller et al. 1983). Fishing activity is generally conducted in waters from 3 to 20 fathoms (18 to 120 feet) although depths vary due to area closures in different locations.

LEVEL OF EFFORT: In central California the halibut fishery in the San Francisco Bay area has been the most extensive in terms of effort and productivity in recent years. During 1983-84 approximately 5,402 gill nets were set and retrieved during the fishing season (Wild 1983). This fishery is conducted primarily from April through October with peak landings in July and August. Gill and trammel nets typically measure 900 to 2,400 feet in length (1,050 feet average) and 18 feet deep. One boat may fish up to five nets at a time.

During the 1983-84 season, fishing was concentrated in 3 to 15 fathoms of water near Bodega, San Francisco and Half Moon Bay areas. Due to a large incidental take of seabirds, closures were enacted for certain areas from Point Reyes to Pigeon Point, Bolinas Point to Point Bonita and Mussel Rock to Point Montara within areas from 10-15 fathoms depending on the area.

The Monterey Bay halibut fishery is conducted primarily in the summer with peak landings in July and August. Gill and trammel nets used in this area generally range from 900 to 2,100 feet in length and 18 feet deep. However, Wendell et al. (1985) reported that some gill nets may be over 6,000 feet in total length. Due to a 10 fathom closure enacted in 1982, most of the fishing effort during 1983-84 was concentrated within 10-15 fathoms.

The gill net fishery in Monterey Bay is conducted by approximately 25 small boats most of which are operated by Indochinese refugees, 20% of which also fish for white croaker with smaller mesh nets. Halibut gill nets are monofilament and range in size from 0.5 to 1.5 miles long and 12 feet deep. Nets are set on the bottom in depths ranging beteen 18 to 72 feet. Typically nets are set to soak for 20-22 hours and are retrieved in the early morning.

The trammel net fishery in Monterey Bay is primarily centered in the northern part of the bay. Major species taken in this fishery besides halibut include starry flounder, lingcod, several species of flatfish, skates, rays and sharks. In recent years this fishery had been conducted by four to six boats (Miller et al. 1983). During 1983-84, approximately 519 nets (including gill and trammel nets) were set and retrieved during the fishing season (Hanan and Diamond n.d.).

In the Morro Bay area, halibut fishing also peaks in July and August. Fishing here is concentrated near Morro Bay and Avila in 6 to 15 fathoms. Trammel nets, both gill net types and the multi panel type, are primarily used. Nets range in length from 600 to 2,400 feet and fishermen will set up to five nets per day. During 1983-84, 13 to 17 boats were active in this fishery (Wendell et al. 1985) and approximately 3,196 gill nets were set and retrieved during the fishing season (Hanan and Diamond n.d.).

In southern California the majority of halibut fishing is conducted with monofilament trammel nets year round with peak fishing in March through June. Nets are typically constructed of 8-inch mesh, 20 mesh deep and from 1,200 to 1,500 feet long. Most of the fishing activity in recent years has been conducted in areas from Oceanside to San Diego and with peak landings during the summer months. The majority of sets occur in water depths of 15 fathoms (90 feet) or less and within 2 miles of the coast. However, regional variations in depth of sets has been noted with nets used in the Santa Barbara-Ventura area generally set in shallower waters (10 fathoms or less) as compared to those set off Dana Point and San Diego areas (20 fathoms or deeper).

INCIDENTAL TAKE/ENTANGLEMENT: The halibut gill and trammel net fishery of central California is adversely affecting several species of marine mammals and seabirds. At present, an estimated 80-100 sea otters die in shallow set nets every year (Wendell et al. 1985). During the past eight years the California population of sea otters, which is listed as threatened, has remained static at about 1,200-1,400 animals. Thus this level of mortality is high enough to have significantly contributed to the lack of sea otter population growth over the last decade.

Sea otter mortalities due to incidental take in the gill and trammel net fishery increased with increased gill net fishing effort and with the expansion of the sea otter's range into areas of intense commercial fishing. The rate of incidental take varies by area, depth, time and fishing gear type in addition to otter behavior. For instance, the incidence of sea otter drownings in gill and trammel nets fished deeper than 12 fathoms (72 feet) is low. Due to a recent closure of gill and trammel net fishing within 15 fathoms from Monterey Bay to Santa Cruz some mortalities will likely be eliminated. Since multifilament nets are more likely to entangle otters than monofilament, restricting the use of multifilament net could also reduce the level of incidental take (Hanan and Diamond n.d.).

From 1983 to 1985, scientists estimate that at least 700 harbor porpoises were taken in the north-central California fishery, although biologists suspect that actual mortality due to this fishery may be even higher (Hanan and Diamond n.d.). Previous analyses of the mesh size of nets used in this fishery, the range of the California population of harbor porpoises and entanglements indicate that harbor porpoises are more likely to be taken in the halibut gill and trammel net fishery of central California than in any other gill net fishery in the state.

The majority of the harbor porpoises killed in 1983-84 were taken in the San Francisco (175) and Morro Bay (73-80) areas where the greatest gill net activity occurs. Although there was no apparent pattern in mortalities in the San Francico Bay area, in Morro Bay mortalities were centered near Morro Bay to Point Piedras Blancas primarily in water deeper than 15 fathoms.

Wild (1985) reported a recent increase in the number of harbor porpoises and California sea lions that have washed ashore during the peak period of halibut fishing in San Mateo County. Some of these animals show obvious signs of net marks.

In Monterey Bay fewer harbor porpoises are taken which may correspond to the fact that fewer nets are fished in this area. Incidental take in Monterey Bay appears to be concentrated in the northern inshore part of the Bay (Hanan and Diamond n.d.). In the early 1980's studies conducted by California Fish and Game personnel estimated that in a single month 15 harbor porpoises may be taken in gill nets in Monterey Bay, in addition to 15-22 harbor seals and 45 California sea lions (Miller et al. 1983).

The level of incidental take of harbor porpoise is of concern because there is currently no reliable estimate of the population from which these animals are being taken nor is there adequate information on reproductive and migratory behaviors. In addition there has been an increase in the number of stranded animals in central California which has coincided with the increase in fishing activity in recent years (Hanan and Diamond n.d.). Table 16 lists reported incidental catch of harbor porpoises in California which have been received by the Smithsonian's Marine Mammal Events Program. All of these reports were in the San Francisco area and most were definitely gill net related.

The halibut gill and trammel net fishery also takes very large numbers of seabirds. Until recently in the San Francisco Bay area from Bodega Bay to Half Moon Bay, the gill and trammel net fishery took an estimated 15,000 seabirds each year, the majority of which were common murres (Wild 1985). Most of the seabird mortality was concentrated in the area of Half Moon Bay, primarily around Point San Pedro in depths of less than 15 fathoms. More than 200 birds have been reported taken in a single net. There has been a recent reduction to 6,000-8,000 birds annually taken in nets but it is not known whether this is attributed to changes in the fishery or to declines in bird populations.

Thousands of migratory seabirds also die in large mesh entangling nets in Monterey Bay during the summer. The majority of these birds are common murres and sooty shearwaters. In 1979, California Department of Fish and Game personnel reported that the number of seabird mortalities in Monterey Bay increased dramatically and was directly associated with an increase in fishing activity with entangling nets in the area. Estimates are that 11,300 common murres and 13,200 sooty shearwaters were taken during a 14-month period from June 1980 to July 1981. In addition, 500 cormorants, 75 pigeon guillemots, 61 loons and 31 grebes were taken during a 14-month period. Peak numbers of carcasses were observed in July (California Department of Fish and Game n.d.).

While the population of sooty shearwaters may be able to sustain this level of mortality, the same is not true for the common murre whose breeding colony inhabits areas from the Farallon Islands to Point Sur. Murres lay a single egg each year, and the chick swims to Monterey Bay from as far as Hurricane Point and the Farallons with one parent upon which it depends for food. If the adult dies the chick will starve.

Cormorants, pigeon guillemots and marbled murrelets may also not be able to withstand such mortalities. The pigeon guillemot in particular has a breeding season that also coincides with the halibut fishery. During the 1980-81 fishing season 284 guillemot carcasses were counted on beaches. This number is larger than the known number of breeding guillemots in the Bay area (California Department of Fish and Game n.d.).

Recently, the gill and trammel net fishery in central California has actually proven to be more effective in catching birds than halibut. In observations of 133 gill and trammel nets obeserved between Bodega Bay to Half Moon Bay 810 halibut were caught, an average catch of 6.1 halibut per net, or 31.3 per mile. The number of birds caught in these nets was 953, 143 more birds than halibut. The average number of birds per net was 7.2, or 36.8 per mile (Wild 1983).

Seabird mortality differs in relation to mesh size and type of net. Larger mesh nets of the halibut fishery take more birds per mile than smaller mesh nets of other fisheries such as the white croaker fishery (Wild 1983). Monofilament and multifilament nets are twice as likely to catch seabirds as nylon twine nets. These nets also catch more birds per mile as compared to nylon nets.

In the southern California halibut trammel net fishery an estimated 220 California sea lions, 73 harbor seals and 24 elephant seals were drowned in this fishery in one year (Miller et al. 1983). Collins et al. (1985) observed common dolphins in addition to California sea lions and harbor seals killed in halibut nets in southern California. Observations of Brandt's and pelagic cormorants, and grebes were also noted entangled in nets. All incidentally taken marine mammals and birds observed taken were dead.

While recent closures to gill and trammel net fishing may have reduced incidental taking in some cases, area closures may not provide all the solutions. For instance, harbor porpoise entanglements in certain areas of Morro Bay occur less often in water shallower than 15 fathoms (Hanan and Diamond n.d.), and the common murre is known to be capable of diving to great depths (California Department of Fish and Game, n.d.). Hence, depth restrictions may be an inadequate measure to prevent the incidental take by gill nets of these and other animals.

Table 16. Harbor porpoises incidentally caught in California, 1983-1985. (Source: Hare pers. comm.).

Date	Location	Condition	Remarks
8/25/83	Pacifica	dead	incidental catch, shallow cuts on flukes, abrasions on tail stock
8/25/83	Pacifica	dead	incidental catch, possible net marks on neck, flukes, fin
8/27/83	Rockaway Beach	dead	showed gill net marks
9/6/83	Montera	?	incidental catch
7/7/84	Muir Beach	?	incidental catch
7/26/84	San Francisco	dead	obvious gill net marks
8/5/84	Fort Cronkhite	dead	gill net
8/5/84	San Francisco	dead	incidental catch
8/8/84	Nicks Cove	dead	gill net
8/18/84	San Francisco	dead	incidental catch; dorsal fin and lower jaw missing
8/18/84	San Francisco	dead	incidental catch; dorsal fin and tail cut off
8/18/84	San Francisco	dead	incidental catch; missing dorsal fin badly mutilated
8/18/84	San Francisco	dead	incidental catch; dorsal fin cut off, mandibles severed
8/20/84	Olema	dead	gill net; found with two dead sea lions and 14 murres
8/20/84	Fort Cronkhite	dead	gill net
8/20/84	Olema	dead	gill net
8/23/84	San Francisco	dead	incidental catch; tail cut off behind dorsal fin, full length ventral cut, eviscerated, cuts in head
8/25/84	Stinson Beach	?	incidental catch
8/28/84	San Gregorio	dead	incidental catch; head, dorsal fin and tail missing

Table 16 (con't) Harbor porpoises incidentally caught in California 1983-1985.

Date	Location	Condition	Remarks
8/29/84	San Francisco	dead	incidental catch; jaw severed, one mandible missing
8/29/84	San Francisco	dead	incidental catch; mandibles severed, one missing, found with animal listed above
8/29/84	San Francisco	dead	incidental catch; jaw severed mandibles gone, dorsal fin and flukes cut off, found with animal listed above
8/31/84	Edgemar	dead	incidental catch; flukes and dorsal fin cut off, skull missing, cut ventrally from belly to chest
10/24/84	Half Moon Bay	dead	incidental catch
2/27/85	Seaside	dead	incidental catch; caught in Cal. Fish and Game net
8/1/85	Daly City	dead	incidental catch; flukes and flippers missing, slash down abdomen
8/1/85	San Francisco	dead	incidental catch; dorsal fin, flukes, mandibles cut off, no teeth in upper jaw

White Croaker Gill Net Fishery

TARGET SPECIES: The white croaker was previously considered to be underutilized in California but the fishery for this species has rapidly increased in recent years in response to expanded markets.

GEAR: White croakers are typically taken with monofilament nets of 2.75 inch mesh. Nets range in size from 10 to 12 feet in height and up to 1 mile in length and are generally set in 2 to 20 fathoms (12 to 120 feet). White croaker nets are generally fished during the day and nets are set for one to four hours at a time. While some nets may be set more than once a day they are generally not left to fish overnight. Since this species is frequently found in dense schools it is not uncommon for catches to be over one ton in a single net.

AREA OF OPERATION: In Monterey Bay this species is fished year round primarily by Indochinese refugees. In southern California, fishing has also increased primarily around Santa Barbara. A major white croaker fishery is off Point San Pedro on Santa Cruz Island.

INCIDENTAL TAKE/ENTANGLEMENT: Wild (1983) reported that the white croaker fishery operating within the area of Bodega Bay to Half Moon Bay may take approximately 6,000 seabirds per year the majority of which are common murres. One monofilament white croaker net observed was one mile long and had 112 seabirds entangled in the net. Wild speculated that the fishery off Point San Pedro could cause substantial mortality due to its size, and it should be noted that the breeding colony of common murres at Point San Pedro has recently disappeared (Ainley, pers. comm.).

White Seabass Gill Net Fishery

TARGET SPECIES: White seabass are targeted by this fishery although other species such as yellowtail, Pacific bonito, halibut, mackerel and sharks are also caught.

GEAR: Most gill nets used for seabass are set on the bottom perpendicular to shore. Nets are typically constructed of multifilament webbing and range in size from 5.125 to 6.5 inch mesh although smaller meshes (3.5) are legal. Most nets are constructed of 6.5 inch mesh, 45 meshes deep and brange between 100 to 150 fathoms (600 to 900 feet) in length. Since seabass deteriorate rapidly once caught in nets, nets are usually fished for periods of less than 24 hours.

AREA OF OPERATION: The white seabass fishery in southern California is conducted over the entire coast with principal areas of operation off Santa Barbara, Point Vincente, near San Diego and at Santa Rosa and San Nicholas Islands (Collins et al. 1985). The season for this species is closed between March 15 and June 15 at which time an incidental take of two fish per landing is permitted. In Baja, seabass may be taken during the closed season.

Peak landings of white seabass occur in mid-June to mid-September. Most fishing is conducted within two miles of shore at a variety of depths ranging up to or greater than 25 fathoms, although the majority of the catch is taken in depths greater than 25 fathoms (Collins et al. 1985).

LEVEL OF EFFORT: Permits are required to land white seabass and in 1983 there were 197 permitees, 144 of which were gill netters.

INCIDENTAL TAKE/ENTANGLEMENT: The incidental take of a single seabird, a pelagic cormorant, was observed in a seabass net (Collins et al. 1985). Fishermen have also reported that California sea lions are drowned in nets in the San Diego area and Baja (Miller et al. 1983) but estimates of total mortality were unavailable.

Rockfish Gill Net Fishery

TARGET SPECIES: Rockfish are the target species.

GEAR: Nets are often multifilament nylon of four to five inch mesh ranging from 10 to 132 feet in height and may be up to one mile in length. Nets here are set for periods of 16 to 24 hours and are typically retrieved in the morning.

AREA OF OPERATION: The gill net fishery for rockfish is conducted from central California to Baja with major fishing grounds located off the southern California islands and offshore banks. The mainland fishery is concentrated off San Diego and in the central California areas of Monterey and Santa Cruz (Miller et al. 1983). A new fishery is developing near the Farallon Islands, in south and west areas, mainly in 50 to 70 fathoms (300 to 420 feet) (Wild 1983).

The rockfish gill net fishery is conducted year round. In central California gill netting is concentrated in waters deeper than 20 fathoms (120 feet). In southern California, rockfish gill netting is restricted to waters deeper than 50 fathoms (300 feet) along the mainland and deeper than 70 fathoms (420 feet) elsewhere. In addition, no more than 100 pounds of rockfish or 200 pounds of rockfish and lingcod may be taken from waters between Point Sal to the Mexican border (Collins et al. 1983).

LEVEL OF EFFORT: In 1983 the Pillar Point Harbor (Half Moon Bay) rockfish fleet consisted of about 16 boats (Wild 1983).

INCIDENTAL TAKE/ENTANGLEMENT: Estimates of marine mammals entangled in rockfish gill nets in southern California include 15 California sea lions and perhaps as many as 15 elephant seals per year (Miller et al. 1983).

Other California Gill Net Fisheries

The California barracuda, Pacific bonito, flyingfish and inshore aggregate species including surfperch, opaleye, halfmoon, jacksmelt, small sharks and other miscellaneous flatfish are also taken in gill nets.

These fisheries use a variety of gill net types. The California barracuda and Pacific bonito fisheries use drift gill nets that are typically set at night. Nets used for barracuda are typically 3.5 to 3.75 inch stretch mesh and are set to drift for 2 to 5 hours while attended by a boat to which one end of the net is attached. The fishery is conducted only during the summer. Bonito are harvested with small nets of a similar size mesh, 3.75 inch. This fishery operates primarily during the winter when other species are not available.

Flyingfish and inshore aggregate species are fished with set gill nets. Nets used for flyingfish are set on the bottom at night in depths of 10 fathoms and are constantly tended by fishermen. Inshore aggregate species are fished with small nylon and monofilament nets ranging in size from 2.5 to 4.5 inch stretch mesh. These nets are typically set near kelp beds or in harbors along the entire coast.

INCIDENTAL TAKE/ENTANGLEMENT Reports of entanglements specifically caused by these fisheries were unavailable. However, it should be noted that fisheries using mesh of similar size have been responsible for taking large numbers of seabirds in inshore areas.

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California Pacific Herring Fishery

TARGET SPECIES: The Pacific herring fishery in California was developed primarily for herring roe which is processed into Kazunoko, a caviar product important in Japan. Interest in the herring fishery for roe grew rapidly as high demand increased prices. In 1979, prices peaked at 10-12 times higher than values at the beginning of the fishery in 1972-73. However, in 1980 the fishery for roe nearly collapsed as consumers boycotted the product due to artificially high prices. The resulting price drop reduced the intensity of fishing. An additional small amount of herring is sold locally for domestic consumption and bait.

In 1984, 8.33 million pounds of herring was taken in California with an value of $1.87 million. Of this amount, 6.5 million pounds was exported at $4.8 million.

GEAR: Purse seines, lampara nets and gill nets are the gear types used in this fishery. There is also a small fishery conducted with round haul nets that take 25 tons during the summer in Monterey Bay (Miller et al. 1983). Fisheries operating during the spawning season are regulated by the Fish and Game Commission in terms of season, quota, and number of fishing vessels permitted to operate in specified areas. Additional restrictions include that no gill net used in this fishery can be longer than 390 feet and that a vessel may set no more than two nets at one time. Gill nets used in this fishery range between 2.0 and 2.5 inch stretched mesh. The allocation for gill net fishermen has increased because their catches have provided the highest roe yields. Closures occur for each gear type as each reaches its quota.

AREA OF OPERATION: The Pacific herring fishery operates during the winter spawning period in San Francisoco Bay, Tomales Bay, Bodega Bay, Humboldt Bay and in the Crescent City Harbor (Miller et al. 1983). The largest roe fishery operates in San Francisco Bay where spawning occurs from November to March and intense fishing activity is carried out over six to eight weeks, for 24 hours, five days per week (Trumble and Humphreys 1985).

LEVEL OF EFFORT: To alleviate overcrowding on fishing grounds in San Francisco and Tomales Bay gill netting is divided into odd and even number groups each of which may fish on alternating weeks. In 1980-81, 100 new gill net permits were issued for San Francisco Bay. In 1984, the number of vessels operating in the herring fishery was 440 with an estimated 880 fishermen.

INCIDENTAL TAKE/ENTANGLEMENT: Marine mammal interactions in California's herring fishery have been assessed by the California Department of Fish and Game (Miller et al. 1983). Fishermen indicated that in previous years net damage by marine mammals and entanglement was greater when drift gill net fishing was permitted in this fishery. Interviews with round haul net fishermen indicated that California sea lions often enter round haul nets and some become trapped and drown. However, the overall mortality of sea lions estimated for this fishery is minimal.

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California Squid Fishery

TARGET SPECIES: In the California squid fishery round haul nets are used to catch squid that are concentrated during times of spawning. Squid fishermen also use this gear to catch mackerel, tuna, herring, and anchovy. In 1985, 20.5 million pounds of squid were landed in California valued at $3.7 million. All squid landings were taken 3 or more miles from shore.

GEAR: Lampara nets and purse seines are types of round haul nets that catch fish by surrounding schools from the sides and from below, thereby preventing them from diving below the net which is then hauled into the boat.

Lampara nets are the forerunner of the purse seine. These nets are bag-shaped with wings. The length of a net from wing to wing may range from 600 to 1,800 feet. Once set around a school, the net is pulled into the boat by the wings and fish are trapped in a smaller mesh bag in the middle. The mesh size of the bag used for anchovies is 11/16 inch and for mackerel is 1 3/8 inch. Lampara nets are more efficient when dense schools of fish are close to port since these nets are easier and quicker to operate with a small crew. Lampara boats range from 40 to 60 feet in length with a crew of four to six.

Purse seines are more efficient when greater numbers of fish are caught per set in deeper water further from shore. These nets are much larger than lampara nets measuring from 1,260 to 2,100 feet in length and up to 300 feet in depth. Purse seines are typically made of 11/16 inch mesh for anchovies and 1 3/8 inch mesh for mackerel. Vessels range from 45 to 90 feet in length and can hold up to 300 tons of fish.

The setting of a purse seine net requires 9 to 12 crew members. A skiff is used to hold one end of the net in place while the vessel sets the net in a circle. The skiff is then used to keep the net from collapsing or to keep the vessel from colliding with the net. Once the net has been set around a school it is pursed by retrieving the cable which passes through heavy metal rings attached along the net's bottom. Once the net has been "pursed" fish cannot escape through the bottom and the net is hauled onboard the ship.

Once a school of squid has been detected with depth recorders, lights are used to attract squid to the surface enabling fishermen to scoop the catch into the boat with dip nets (Miller et al. 1983).

AREA OF OPERATION: The commercial squid fishery in California has operated in Monterey Bay and areas of southern California. Historically, the Monterey Bay squid catch has comprised the major portion of state landings but in recent years more squid is taken in southern California.

The squid fishery operates during the spawning period. Fishing is conducted at night and in the early morning when squid are near the surface. At Santa Catalina Island spawning occurs November through March with a peak in December or January. In the Santa Barbara area spawning peaks in December or in spring from March to May. In Monterey Bay, squid spawning may occur throughout the year with spring and fall peaks but commercial quantities of squid are absent from December to March (Miller et al. 1983).

In southern California the major area where squid are taken is Santa Catalina Island. Here dip net light boats are primarily used and most squid are taken on the seaward side of the island. In certain instances a dip net vessel will make agreements with purse seiners to allow the seiner to take squid attracted by the dip net light boat under the conditions that a portion of the seine catch will be given to the dip net boat.

LEVEL OF EFFORT: In the early 1980's there were 30 purse seine vessels operated out of San Pedro and four or five were in Monterey. At the same time 22 lampara boats operated in southern California and 20 operated in central California for live bait at Morro Bay and for herring, squid, anchovies and mackerel in the Monterey Bay and San Francisco Bay areas (Miller et al. 1983). In 1984, there were 117 to 159 vessels fishing for anchovy, mackerel and squid using seines, lampara and dip nets (Stadler 1985). Due to increased demand for squid this fishery is rapidly expanding (Miller et al. 1983).

INCIDENTAL TAKE/ENTANGLEMENT: The California sea lion is the major species involved in interactions with the round haul net fisheries but estimates on total mortalities were unavailable. According to researchers studying these interactions, between 60 to 100 California sea lions may be killed in the squid fishery around Catalina Island each year (Shane pers. comm.).

Other reports of marine mammals taken in these fisheries include gray whales in lampara nets although fishermen report that these whales often escape through the webbing without any apparent injury. Harbor porpoise have also been reported to be taken in round haul nets set for anchovy.

Pilot whales have been reported to be caught in squid purse seine nets and are either drowned or entangled in the net and killed once taken on board the vessel. Apparently, pilot whales will not swim over the upper edge of a net once they have been entrapped and at times the tail will become entangled in the webbing. When the net is being retrieved the animal appears tail first, suspended in the air at which time fishermen may cut off their tail flukes releasing the whale carcass from the netting. As many as 4 to 12% of the pilot whale population may be killed by squid operations around Santa Catalina Island (Miller et al. 1983).

Marine mammal interactions with the squid fishery have been documented by Department of Fish and Game personnel on the seaward side of Santa Catalina Island where squid fishing is conducted and which is also the location of California sea lion haulout sites and where pilot whales are most concentrated. Consequently, during the peak in squid spawning from November through March there is a concentration of squid, marine mammals and fishing activity in this area.

Fishermen generally regard sea lions and pilot whales as competitors and often shoot or throw bombs at animals, primarily seals. Occasionally dead seals are found floating in the vicinity of squid operations. Fishermen have also been reported to use bombs set off in plastic containers to deter gulls. Many dip net fishermen, however, do not have intense feelings of animosity toward pilot whales and even regard the proximity of a whale to a dip net boat fishing for squid as advantageous in herding squid closer to the boat. However, with the expected increases in purse seine vessels in this fishery, marine mammal interactions will become more frequent (Miller et al. 1983).

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California Trawl Fisheries

TARGET SPECIES: Trawling gear is used in four primary types of fisheries in California: rockfish and deep water flatfish, southern California halibut, hake and widow rockfish, and shrimp fisheries. Bottom trawls are used for rockfish, halibut and shrimp whereas mid-water trawls are used for hake and widow rockfish. This mid-water fishery is relatively new and operates in northern California.

GEAR: Trawl nets used in these fisheries, with the exception of the shrimp fishery, have codends with mesh sizes no smaller than 4.5 inch stretch mesh (Miller et al. 1983).

LEVEL OF EFFORT: In 1984, 171 trawlers received permits for groundfish in California (Stadler 1985).

INCIDENTAL TAKE/ENTANGLEMENT: California sea lions, attracted to the fish caught in a trawl, often follow trawling operations feeding on small fish that fall through the net. On occasion, sea lions will be found inside a trawl net, most of them drowned. However, total mortality attributed to this fishery has not been fully studied. It has been estimated that approximately 20 sea lions are taken in trawl fisheries every year (Miller et al. 1983). However, one halibut trawl fisherman reported that as many as eight sea lions may be caught in one week which indicates that the actual level of sea lion mortality attributable to this fishery may be greater.

Observations of pinnipeds at San Miguel and San Nicolas Islands in recent years have noted elephant seals entangled in pieces of trawl fragments which were presumably encountered as debris rather than during active fishing operations (Stewart and Yochem 1985). These fragments apparently had holes in the mesh large enough to slip over the animals' heads. Pieces of netting found on entangled animals and on the beaches in these areas ranged between 4.75 inches to 10.75 inches (10.2 to 26.7 cm). On the basis of observations of entangled animals, it has been suggested that trawl netting causes mortality of entangled animals more frequently than monofilament nets or other debris. Animals with scars indicative of previous entanglements with trawl netting have not been observed whereas animals with scars caused by monofilament fishing line are commonly reported.

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Fisheries of the Northwest and Alaska

Oregon and Washington Dungeness Crab Trap Fishery

TARGET SPECIES: Dungeness crabs are harvested by fishermen in all major coastal ports of Oregon and Washington. Only male crabs of legal size may be taken in this fishery. Traditionally, this fishery has been highly lucrative but unstable in terms of level of catch. In 1977, official landings data for Oregon shows that 19.9 million pounds of crab were harvested valued at $8.5 million dollars. In Washington, nearly 15 million pounds were landed valued at $7 million. In 1985, preliminary landings data indicate that landings have declined dramatically and consequently value has increased. In Oregon 7.4 million pounds of crab valued at $10.7 million was landed in 1985. In Washington, approximately 5 million pounds of crab was harvested valued at $7.2 million (National Marine Fisheries Service, Office of Data and Information Management, unpublished data). Dungeness crabs are also commercially harvested in California and Alaska with 6.2 million and 9.7 million pounds landed in 1985 in these states respectively.

GEAR: Dungeness crabs are harvested in traps or pots. The pots are typically constructed of a circular metal frame 36 to 48 inches in diameter with 3 to 4-inch stainless steel wire mesh. Ocean pots can weigh approximately 75-160 pounds each and traps used in bay areas of Washington are 50 pounds. Each dungeness crab pot is attached to a 50-60 fathom-long rope with two buoys at the surface. The buoys are spaced from 5 to 10 fathoms apart. Dungeness crab pots are set in waters from 18 to 480 feet deep. Pots are checked every one to seven days depending on fishing conditions but remain in the water throughout the season.

Depending on the vessel size, from 100 to 1,500 pots are fished at one time. During retrieval, a two-man crew can average 30-40 pots per hour harvesting up to 60 crabs per pot.

AREA OF OPERATION: In 1985 approximately 75% of Oregon's and Washington's total commercial crab catch was landed within three miles of shore. The dungeness crab fishing season in Oregon extends from December 1 through August 14. The majority of dungeness crab fishermen also participate in other fisheries such as groundfish or salmon.

LEVEL OF EFFORT: The most current official data available on the level of fishing effort in this fishery are for 1977. At this time there were 1,646 fishermen with 118,321 traps engaged in the Oregon and Washington fisheries combined (U.S. Dept. Commerc. 1984). The majority of fishing effort was concentrated in Oregon coastal areas with 650 fishermen and 60,285 traps. In Washington, 346 fishermen with 15,510 traps were used in coastal areas. An additional 344 fishermen with 24,226 traps fished in the Columbia River and 306 fishermen with 18,300 traps fished in the Puget Sound.

INCIDENTAL TAKE/ENTANGLEMENT: Gray whales have been the most commonly reported cetacean entangled in fishing gear along the Oregon coastline, and since 1968 crab traps have been associated most frequently with cases of entanglement (Mate 1985). During 1976-78 experimental crab fishing was conducted off Oregon using conventional crab traps that were modified with a longer length of line between the two trap buoys. During this time between five to eight gray whales every year became entangled in this line. This gear was also fished near shore due to winter storms and gray whales became entangled when they migrated closer to shore during good weather. In all cases the rope was caught between the whale's baleen plates, and it was assumed that this occurred when the animal was surfacing. Often the whale would become further entangled around its flukes or flippers in an apparent effort to dislodge the gear.

Entanglements of gray whales off the central Oregon coast have continued throughout the years with an estimated two whales per year becoming entangled in crab trap lines (Mate 1985). Since traps are moved closer to shore during the spring following the spawning migration of the crabs, they are more likely to encounter whales migrating along the coast.

Although the fate of many of these whales is not known one was found dead in 1977 with a fractured tail and wounds indicative of entanglement (Mate 1985). Since 1978 the Oregon Department of Fish and Wildlife has received two reports of gray whale entanglements in crab pot buoy lines; one was freed and the other died (Snow pers. comm.). A minke whale was also found dead in 1982 with a crab pot line through its mouth which had worn through to the bone (Mate 1985). In April 1984 a gray whale was reported floating entangled in a rope in Liberty Bay, Washington, but it is not known whether this was a rope from a crab trap or a gill net (Hare pers. comm.).

In recent years the number of gray whale strandings in Oregon and Washington have been unusually high. In 1983 and 1984, 27 gray whales stranded each year in this region, many more than the two to four annual reports received in previous years (U.S. Dept. Commerce 1985). Although the crab trap fishery may not be the primary cause for mortality, this and other fisheries in the region should be closely monitored to determine how they may be contributing to this overall mortality level.

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Oregon-Washington Salmon Gill Net Fisheries

TARGET SPECIES The salmon fishery was one of the first and most valuable fisheries on the Pacific Coast of the United States. Historically, salmon were harvested by native Indians in the Columbia River and other areas. The impetus for a commercial fishery came from the introduction of canning of salmon which began in the Sacramento River area of California and subsequently spread north to Puget Sound, British Columbia and Alaska. Ultimately the Pacific salmon fishery supported more fishermen, vessels and canneries than any other fishery in the United States. The more recent history of the salmon fishery has changed by the growing demand for fresh, frozen and smoked salmon as well as caviar, and the canning industry has declined.

Salmon are highly prized by both sport and commercial fishermen in Washington and Oregon. Historically, the Columbia River supported a major concentration of salmon but overfishing, habitat loss and other factors have caused stocks to decline. At one time the Columbia River was home for four species of salmon: the chinook, coho (silver), chum and sockeye (red), but chinook and coho now sustain most of the commercial harvest. Grays Harbor and Willapa Bay, in the past, yielded one third the commercial salmon catch of the Columbia River. Being anadromous species, salmon spend part of their life in the ocean and enter fresh waters to spawn. Due to variations among species there is almost a continual supply of salmon in this area throughout the year.

Salmon have a unique sense of smell. As young, the odor of their home streams becomes "imprinted" in their memory. Later this memory enables salmon migrating from the ocean to recognize and return to their home rivers to spawn. This characteristic of salmon has given strong impetus to artificial propagation through hatchery programs to increase salmon stocks. Adult salmon are captured and their young are artificially reared and released into their native stream. Hatcheries protect young salmon from natural predation and disturbances and therefore ensure that more young survive. Many salmon presently returning to the Columbia River, for example, have been reared and released from hatchery programs that have operated since 1959 (Laufle et al. 1986).

In 1985, salmon landed within 3 miles of the Washington coast accounted for 88% of the total state catch with 57 million pounds valued at approximately $42 million. Gill nets, in combination with landings from seines, accounted for 8.7 million fish in the 1985 fishing season in Washington the rest being taken by trollers (Miller 1986). Over 90% of Oregon salmon were landed in coastal areas (within 3 miles) with 3.6 million pounds valued at about $5.2 million (preliminary data, National Marine Fisheries Service, Office of Data and Information Management). Chinook salmon, the largest of all salmon species, accounted for almost 65% of the Oregon catch. Although recent information is not available, Washington salmon landings for 1977 from the Columbia River accounted for 3% of the total state catch, coastal areas including Willapa Bay and Grays Harbor comprised 14%, and Puget Sound landings accounted for 80%. In Oregon, 36% of the state's salmon catch was taken in the Columbia River.

GEAR: Drift gill nets are the only commercial gear allowed for salmon in the Columbia River. The maximum legal length is 457 meters (1,500 feet) for drift gill nets. In the upper portion of the River, above the Bonneville Dam, set gill nets and dip nets are permitted to be used by treaty Indians in the exclusive Indian commercial fishery. Throughout the year gill net mesh is regulated to protect certain species at different times of the year; in February-March and in August a 184 mm (7.3 inch) minimum mesh size is enforced to reduce the catch of steelhead trout; in June-July the minimum mesh is reduced to 114 mm (4.5 inches) in the sockeye salmon fisheries to protect chinook salmon entering the river in summer. The Grays Harbor and Willapa Bay salmon fisheries are conducted with drift gill nets 457 meters (1,500 feet) long with a minimum mesh size of 124 mm (4.8 inches). Puget Sound fisheries obtain the greatest catch from purse seines and drift gill nets which may be 549 meters (1,800 feet) in length with stretch mesh between 114 to 210 mm (about 4.5-8 inches) determined by area, season and species (Uchida 1985).

Oregon fishermen can use gill nets in the Columbia River for salmon, sturgeon, shad and smelt but they may not used them in the ocean. The salmon fishery is the primary gill net fishery, but its season is limited to a few weeks per year. Mesh size is strictly regulated to prevent catching steelhead trout. Gill nets are 1500 feet in length.

AREA OF OPERATION: The Columbia River salmon fishery is conducted from February through September and is divided into four seasons: winter (January-March) spring (April-May), summer (June-July), and fall (August-September). As spawning progresses through fall larger numbers of chinook, coho, then chum salmon pass through estuaries and into rivers, therefore, catch per unit of effort increases then declines through November. Salmon "runs" are light in the lower estuary fisheries of Grays Harbor and Willapa Bay in summer and in the Columbia River in winter. The Puget Sound fishery extends from May through October (Uchida 1985).

Salmon fisheries are strictly regulated by the Washington Department of Fisheries so that each year's fishing will not adversely affect future stocks. Consequently, there is intense competition for limited salmon stocks among gill netters, treaty Indians and commercial sportsmen. For each river in the state the amount of salmon expected to enter the river is estimated as well as the number of spawning salmon necessary to maintain salmon stocks (referred to as the "escapement goal" meaning the number evading fishermen and reaching spawning grounds). These estimates vary from year to year and throughout the season. From these predictions and projections the catchable allocation of salmon in each individual river is determined. Treaty Indians receive roughly half of the allocation. The non-Indian share is then divided between commercial fishermen and sports fishermen.

LEVEL OF EFFORT: In 1981 there were a total of 659 gill net vessels participating in the salmon fishery of the Columbia River area including Willapa Bay and Grays Harbor (Pacific Fishery Management Council 1983). In Puget Sound 1,448 salmon gill net vessels were in operation.

INCIDENTAL TAKE/ENTANGLEMENT: In 1980 the Washington Department of Game began to study the marine mammal/commercial fishery interactions in and around the Columbia River. The major objectives of this study were to determine the extent of damage inflicted by marine mammals on commercial salmon fishing gear and catch and the level of incidental take of marine mammals in these fisheries. The results of this study demonstrated an intense conflict between salmon gill net fishermen and marine mammals, specifically seals, in the area. Not only are seals responsible for a considerable amount of damage to fishing gear and salmon caught but they are incidentally taken in these fisheries and sometimes killed by harassment. In general, fishermen view these animals as pests and serious competitors.

Based on interviews with fishermen it was estimated that marine mammal/fisheries interactions occur in 62% of the salmon gill net fishing trips in the Columbia River, Grays Harbor and Willapa Bay salmon fisheries (U.S. Dept. Commerc. 1985). In 1980 a conservative estimate of 671 marine mammals were either entangled or harassed by gill net fishermen (Beach et al. 1981). Of these a minimum of 52 animals were entangled in fishing gear and 619 animals were harassed by the use of explosives, gunshot or running at animals with a boat. Fishermen in the area commonly use "seal bombs," or hand-thrown firecrackers to deter seals from coming near their nets. A miminum of 60 animals died due to these interactions. However, the incidental take for the entire fishery is undoubtedly higher. According to the Washington Department of Game (Gieger pers. comm.) 350 harbor seals and 45 California sea lions are killed each year in gill nets.

An increasing number of harbor seals and California sea lions in the area have accounted for increasing conflicts with fisheries. Since 1976 the harbor seal population has increased at a rate of about 22% per year, and among the marine mammal fisheries interactions in 1980, approximately 99% involved harbor seals. 51 became entangled in nets and 613 were harassed, but these estimates are conservative. Harbor seals that become entangled in nets usually die either by drowning or being clubbed or shot by fishermen.

The season and location of damage caused by seals and the rate of incidental take and entanglement are generally correlated with the relative abundance of seals and salmon catch rates. In the Columbia River proper, harbor seal and California sea lion numbers increase to a peak in winter. Consequently, conflicts between seals and gill net fishermen at this time are intense. But these interactions are compounded by the fact that salmon are relatively scarce and consequently more valuable in the Columbia River in winter.

The Grays Harbor summer salmon fishery has been identified as a time of intense interaction as well. Prior to the fall season, gill nets in Grays harbor are placed at the mouth of the harbor to target concentrations of chinook salmon. This also puts nets in the vicinity of major harbor seal haulout sites and directly in the path of seals passing between the ocean and the harbor. Since overall salmon catches are poor at this time, there are not only intense conflicts between seals and fishermen but the cost incurred by marine mammal damage to fish is again more severe since each fish is relatively more valuable at this time.

However, not all seal interactions with gill nets are attributed to pilfering of fish. High rates of net damage in the Columbia River caused by California sea lions have been attributed to occasions when these animals were in pursuit of fish other than salmon and accidentally swam into gill nets. The most serious type of gear damge caused by marine mammals results from entanglements where a seal has to be cut free.

Information obtained from animals found stranded in this area indicates that incidental take and harassment of marine mammals involves several other seal species such as northern fur seals, northern sea lions, northern elephant seals, as well as cetaceans. During a 14-month period in 1980-81 a total of 173 marine mammals were found stranded in the Columbia River area. The primary cause of death for examined animals was either gunshots or drowning. Deaths attributed to clubbing and underwater concussions were also reported. Of the pinnipeds examined, 46% of the deaths were human-related. Although most of the cetaceans were not found in the Columbia River area, a gray whale swam through a gill net set at the mouth of the Columbia River in 1981. Another incident of a gray whale was reported in the Columbia River in January 1984 (Hare pers. comm.). This animal was found dead with an 8-inch stretch mesh gill net wrapped around its tailstock. Gaskin (1984) reported that many of the 19 harbor porpoises found stranded along the coast of Washington showed signs of gill net entanglement. He also reports that several captures of harbor porpoises by Indian fishermen go unreported each year.

Due to the high level of incidental take and damage to gill nets caused by marine mammals, the National Marine Fisheries Service (NMFS) granted a general permit to fishermen in various salmon fisheries of the North Pacific Region to take a specified number of marine mammals during commercial fishing operations. All gill net and troll fishermen (trolling gear are baited hooks pulled behind a boat) are permitted to take 750 northern sea lions, 10 northern fur seals, 1,200 harbor seals and 200 cetaceans. This number includes marine mammals taken by all fishermen who have Certificates of Inclusion under this permit. The Northwest Region of NMFS encourages fishermen to obtain Certificates of Inclusion to enhance their cooperation in obtaining information on marine mammal/fisheries interactions. To date 4,000 Certificate holders have been included (U.S. Dept. Commerce 1985). According to one of the authors of the original Columbia River study (Gieger pers. comm.) the estimates for animals permitted to be taken by the gill net and trolling fishery in Washington were based on the number of animals taken in the Columbia River. Overall take was then extrapolated from these estimates. Since NMFS quotas were set, however, a new sturgeon gill net fishery has developed in the Columbia River. But NMFS has not adjusted its quota to include marine mammal takings from this fishery. This is important because the NMFS quotas are assumed to reflect actual levels of incidental take. In fact, the levels of take may be exceeding the NMFS quota (Gieger pers. comm.).

While the incidental take of marine mammals in the salmon fisheries of Washington are being monitored, seabird mortalities, which may be an even more serious problem, are not. In the northern portion of Puget Sound dead seabirds, primarily western grebes and common murres, have been observed at times in unusually high numbers on the shoreline. In the late 1970's one observer reported about 50 common murre carcasses on a beach at Point Roberts, the northernmost point of Washington (Wahl pers. comm.). Reportedly, salmon gill net fishermen were operating in the area. In other areas gill net and purse seine fishermen have been observed with birds in their nets. One gill net fisherman admitted to catching as many as 10 birds per night. In fact, some fishermen have indicated that it is much more common to catch seabirds as compared to seals especially off of Salmon Bank in the Strait of Juan de Fuca (Ozborn pers. comm.). At the mouth of Grays Harbor there is also a significant seabird catch (Gieger pers. comm.). Considering the hundreds of gill net fishermen operating in this area, the salmon gill net fishery may be causing significant seabird mortalities.

The magnitude of incidental take of seabirds in the salmon fishery of Washington is completely unknown. Available information is only anecdotal at this time but suggests that the problem in Puget Sound begins in fall when seabirds migrate into the area and is compounded by the fact that the salmon fishing season has recently been extended through this period due to increased stocks (Wahl pers. comm.). In previous years the salmon fishery ended in October. With increased stocks the fishery may run as long as December. Western grebes start to migrate into the area in September. Therefore, the fishing season and seabird concentrations overlap. Other factors that could be contributing to this problem are that gill nets are fished primarily at night when common murres and other alcids feed and river mouths are prime areas for both seabird feeding and salmon fishing (Wahl pers. comm.). In addition, salmon fishermen are shifting their fishing operations to shallower waters where western grebes and loons are suceptible to being caught (Jehl 1984).

Some feel that the seabird incidental take problem has not received attention because salmon fishermen already have their share of problems with intense competition for salmon stocks (Wahl pers. comm.). However, the problem should be investigated. Not only may the loss of western grebes be affecting populations, but for common murres the problem is more complex; many murres in the Puget Sound area move south to California in the fall where they may also be taken in fisheries there (Wahl pers. comm.).

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British Columbia, Barkley Sound Gill Net Fishery

TARGET SPECIES: Traditionally the gill net fishery of Barkley Sound has primarily targeted sockeye salmon. In 1980, over 400,000 pounds of salmon were taken in gill nets in this area.

GEAR: Gill nets used in this fishery are multifilament nylon of 135 to 375 meters (440 to over 1,230 feet) in length, less than 10 meters (33 feet) in depth with mesh sizes of 10-13 centimeters (4 to 5 inches). Nets are primarily fished during the day with fewer nets set a night.

AREA OF OPERATION: The gill net fishing season in Barkley Sound is regulated through four phases; February through May; early June; late June through late July and short open periods in fall. Barkley Sound proper is closed to gill net fishing from late July to February with the exception of short openings during late fall. Gill net fishing is minimal in February through May due to mesh size restrictions. In early June, however, effort increases to peak in late June. At the end of late July gill net fishing shifts to Alberni Inlet to control the harvets of salmon from specific spawning rivers.

LEVEL OF EFFORT: In 1979, during peak gill net times 62 gill net boats operated in early June, 215 boats in late June through late July. This is comparable to the average number of vessels (207) operating during the peak fishing season during 1975-79. During 1979 South Trevor Channel had the highest concentration of gill net boats with an average of 44 boats per day during the peak season. Other areas such as Cape Beale and North Trevor Channel had an average of 28 and 15 boats per day, respectively. In 1980, the largest annual effort was spent in the gill net fishery with over 6,000 fishing days as compared to previous years. Effort in this fishery is said to be increasing.

INCIDENTAL TAKE/ENTANGLEMENT: The Barkley Sound gill net fishery season coincides with the nesting period of the marbeled murrelet, the most abundant breeding seabird in this area. During the 1979 and 1980 gill net season researchers investigated seabird/gill net fishery interactions to determine what level of mortality was attributed to this fishery (Carter and Sealy 1984). The majority of fishermen did not cooperate in the study but indicated that they caught birds every year.

The marbled murrelet incurred the highest mortalities. Other birds reported taken incidentally in gill nets included common murres and rhinoceros auklets. Almost all of the the marbled murrelets (90%) incidentally taken in nets were breeding, based on the presence of a brood patch indicating that they were either incubating eggs or feeding nestlings. This species was taken almost entirely at night whereas common murres were taken at night and during the day. The depth at which these birds were found in the nets ranged from 2 to 10 meters with the majority of murrelets taken within 2 meters of the surface. Common murres were also taken in nets between 6 and 8 meters from the surface.

For this two-year period a total of 33 alcids were reported killed in gill nets. Five fishermen in 1980 reported 24 birds which had been caught in their nets. Based on total fishing effort, it was estimated that 175-250 marbled murrelets were killed by gill net fishermen in 1980. This number represents 6.2% of the breeding individuals in this area. However, the overall level of mortality caused by gill nets is more extensive than this. Each murrelet nest has one young per year, and a nestling will not survive if it is left to be raised by a single parent. Therefore, for each breeding murrelet killed in a gill net one nestling will die in the nest. Using a conservative estimate of 200 birds killed in gill nets each season, 90% or 180 would be breeding birds. Therefore, 180 nestlings also died. Thus, a total of 380 marbled murrelets died both directly and indirectly due to gill nets. This number represents 7.8% decrease in the potential population growth of this colony.

The cumulative effects of this level of mortality year after year could have severe impacts because it is directed at a small population in Barkley Sound. Two measures that could mitigate this problem would be to eliminate gill net fishing in areas of marbled murrelet aggregations and prohibit gill net fishing at night when most mortalities occur.

Many other instances of seabird mortality in gill nets have been reported in British Columbia including: the deaths of ancient murrelets and rhinoceros auklets in gill nets at Langara Island, at the northern tip of Queen Charlotte Islands; observations of large numbers of dead common murres in gill nets along the southwest coast of Vancouver Island; and a fisherman who reported 500 ancient murrelets that drowned in his gill net on the west coast of Graham Island in one year (Vermeer and Sealy 1984). Clearly there is a need to study the effects of gill netting on seabirds in British Columbia.

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Alaska Salmon Net Fisheries

TARGET SPECIES: On the northern shore of the Gulf of Alaska the Copper River and Bering River fishing districts extend over 80 miles. The salmon fishery is of major importance to this area, harvesting five species including sockeye, chinook, chum, pink and coho. The river systems of Bristol Bay support the largest sockeye salmon fishery in the world; in 1983 over 35 million sockeye were harvested in this area.

GEAR: Alaskan salmon are harvested with a variety of net gear types including purse seines and drift and set gill nets. Salmon gill nets account for a large portion of the state's catch. The gear regulations for gill nets in the Alaskan salmon fishery are very complex varying by location and season. In general where drift gill nets are permitted legal maximum length is 900 feet. For set gill nets, the legal length is: 27-549 meters in southeast Alaska; 274 meters in Kodiak; 366 meters in the Alaska Peninsula-Aleutian Islands; 91 meters in Bristol Bay and 183-274 meters in Arctic-Yukon-Kuskokwim area. Gill net mesh sizes range from 133-137 mm in the Alaska Peninsula-Aleutian Islands and Bristol Bay areas to 203 mm in southeast Alaska.

In the Copper River-Prince William Sound area drift gill nets are set for periods of 15 minutes to 8 hours depending on fish concentrations, weather and other factors. In general nets are not set for longer than 2 to 3 hours since dead fish tend to drop out of the net more easily during longer sets and the potential for predation by marine mammals is considered to increase with time. The length of net and time of set is typically influenced by water depth with longer nets set for greater periods of time in deeper water. One end of the boat must be attached to the net at all times while it is in the water. From one to several hundred salmon may be caught in a single net with an average of 50 fish per set.

AREA OF OPERATION: The Alaska Department of Fish and Game manages the salmon fishery with seasonal closures and quotas. Emergency closures are invoked at any time when salmon stocks appear to be too low to maintain subsequent harvests in succeeding years. The spring season for salmon fishing in the Copper River typically begins in May and is directed primarily at sockeye and chinook salmon. Most of the fishing and catch is conducted during the first five weeks. In autumn coho salmon is the principal species taken on the Copper River and Bering River deltas. Salmon fishing in the Coghill fishing district (located in the northwestern portion of Prince William Sound) generally begins in mid-June and lasts for five weeks, targeting sockeye salmon with pink and chum caught as the season progresses. The Coghill fishing district is the main area in Prince William Sound where salmon drift gill netting occurs. Since fishing is staggered between these areas, fishermen typically move from the Copper River to the Coghill district after the spring fishery. In autumn fewer fishermen participate, in part because of unfavorable weather.

In the Bristol Bay area the first red salmon appear in Kvichak and Nushagak Bays in mid-June, peaking during the last week of June through the first two weeks of July. After mid-July the red salmon run decreases and chum, pink and coho are present in smaller numbers.

LEVEL OF EFFORT: The salmon fisheries of Alaska are regulated by "limited entry" meaning that a limit is placed on the number of "gear units" operating in an area. A gear unit is one boat and one net. In the early 1980's approximately 500 gill nets were permitted, although seldom more than 450 were used in the Copper River, Bering River, and Prince William Sound area (Matkin and Fay 1980). The majority of permit holders are not full-time residents of Alaska, coming from Washington and Oregon to participate in the fishery.

During the peak fishing season of 1983, an estimated 1,000 drift gill net vessels and 344 set gill nets were fished in Kvichak Bay with an additional 300-600 drift gill nets and as many as 230 set nets in Nushagak Bay. The combined length of nets fished in these two bays was 450 kilometers.

INCIDENTAL TAKE/ENTANGLEMENT: Problems of incidental take and entanglement in the Alaska salmon gill net fisheries are complex and in some areas relatively undocumented. The following information, therefore, is provided to illustrate some of the fishery conflicts reported in literature.

In the late 1970's marine mammal/fishery interactions were assessed in the Copper River and Prince William Sound areas of Alaska (Matkin and Fay 1980). Based on interviews with fishermen an estimated 1,000 marine mammals were taken in salmon gill nets. Approximately half of these animals were harbor seals, 40% were sea lions and the remaining animals killed were harbor porpoises, Dall's porpoises and sea otters.

Levels of incidental take of marine mammals were found to depend not only on the species' abundance, but also on the attitudes of fishermen toward these animals. The incidental take of harbor seals was greater than that of sea lions in the Coghill fishery and in the autumn Copper River-Bering River fishery because of the relative abundance of harbor seals and scarcity of sea lions in fishing areas. Conversely, during the Copper River spring salmon fishery the incidental taking of northern sea lions was greater than that of harbor seals which was suggested to be a result of the fishermen's negative bias toward sea lions rather than their relative abundance or frequency of interactions with this fishery.

The effects of incidental take of harbor porpoises on species population are not known. A total of 102 harbor porpoises were reported netted and 58 were killed. Almost all harbor porpoises captured in this fishery were taken within waters 5 kilometers from the barrier island shores. Overall take of harbor porpoises was estimated to be 100 porpoises per year and half of these animals die. Although gill net fishermen are permitted to take certain species of marine mammals under a general permit granted by the National Marine Fisheries Service, harbor porpoises are not permitted to be incidentally taken in any Pacific fishery because so little is known about the population size (Hollingshead pers. comm.). There is also limited information on the population size of Dall's porpoise but these animals are permitted to be taken in the course of commercial fishing. A total of 41 Dall's porpoises were caught by salmon fishermen in the Coghill summer salmon fishery, 31 of which drowned in the net. No Dall's porpoises were taken in nets in the Copper River area. An additional 76 sea otters were captured in gill nets, the majority of which were released.

Marine mammals prey on fish caught in gill nets and therefore are of concern to fishermen. It has been estimated that in the Prince William Sound-Copper River Delta area $500,000 worth of catch and gear damages is attributed to seals and sea lions every year (Steiner pers. comm.). Although some fishermen view the occasional loss of fish as merely an occupational hazard, this viewpoint is only representative of a minority of fishermen. The majority carry shotguns or seal bombs to deter animals from their nets. One fisherman reported that he had shot 115 seals and sea lions even before the season began. The shock wave from a seal bomb can be felt through the hull of a boat and could presumably cause severe pain or injury to marine mammals in the area. Researchers are presently attempting to develop alternative methods to deter marine mammals. Interestingly, fishermen have commented that they have less gear damage when killer whales are in the vicinity of fishing operations and expressed an interest in using tapes of killer whale vocalizations while fishing. In addition, various proposed modifications in fishing strategies may minimize damage to catches such as shorter gill net sets, fishing in morning and afternoon, fishing outside of the Copper River and nearer to the shore and in estuaries of the Coghill district.

Bristol Bay is home to a large number of beluga whales during the summer, which is also the time of the sockeye fishing season. Fishermen consider these whales to be significant predators of salmon, although studies have shown this not to be the case especially for sockeye salmon (Frost et al. 1984). Recent documentation indicates that beluga whale entanglements in salmon gill nets during the summer is thought to be a significant problem in Bristol Bay (Melteff and Rosenberg 1984). Until 1983, five to ten whale entanglements in gill nets were reported each year. But in 1983, at least 27 dead whales were found. Although 12 of these deaths were definitely fishing-related (Frost et al. 1984), fishing nets were implicated in the other deaths. Six whales were killed in chinook salmon nets, four were found in pink salmon nets and two were found in nets that could not be identified as to the target salmon species. Researchers in this study commented that in at least two instances whales that were known to be killed in nets showed no obvious signs of entanglements. Therefore the difficulty in determining cause of death in beach-cast whales could result in underestimates of fishing-related mortalities not only for this fishery but other U.S. fisheries as well. The current mortality is undoubtedly an underestimate for other reasons as well, including the difficulty in locating carcasses or incidents of entanglements.

Belugas become entangled in two ways; smaller animals become entangled in the mesh and larger animals often become entangled in the lead or corklines of the net and subsequently roll, becoming wrapped in the net. For these larger individuals the only release is by cutting the net and at times the tail flukes may be cut off during the process. In five of the whale entanglement cases set gill nets were involved. One case occurred in a drift gill net and the type of net involved in the other six cases was unknown. The cause of increased beluga whale mortality attributed to salmon gill nets in recent years is in need of future study. Ten to 20 harbor porpoises each year also become entangled in Bristol Bay and Norton Sound (Melteff and Rosenberg 1984) in addition to gray whales that are prone to entanglement in gill nets because they migrate along shore (Steiner pers. comm.).

Seabird mortality attributed to gill nets is suspected to be widespread throughout southeastern Alaska. In the Copper River and Bering River from 100 to 300 marbled murrelets die during gill net fishing operations each year. In the Coghill, Unakwik and Eshamy fishing districts over 500 marbled murrelets are killed per year. Since marbled murrelets aggregate in relatively small areas where fisheries operate, serious consideration should be given to closing these areas to gill netting (Sealy and Carter 1984).

Marine mammal or seabird interactions in other areas of Alaska where major domestic salmon gillnet fisheries occur is poorly documented. In June 1985 a humpback whale was released from a salmon drift gill net south of the Juneau Coast Guard station (Hare pers. comm.). The salmon purse seine fishery in these areas is also involved in some incidental take, primarily seals, but overall levels are thought to be insignificant (Melteff and Rosenberg 1984).

Although fishermen in Alaska can take marine mammals incidentally under a Certificate of Inclusion under the North Pacific Fishing Vessel Operators General Permit, very few apply for this exemption (Steiner pers. comm.). Therefore, not only is valuable information that could be obtained from this reporting system lacking, but there is no way to determine what level of incidental taking of marine mammals is occurring in this fishery.

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Gulf of Alaska Sablefish Fishery

TARGET SPECIES: The sablefish, or blackcod, has become of increasing commercial importance in the United States. Although sablefish is actually a "false cod," not a true member of the cod fish family, the development of the sablefish fishery has been inspired by the successful marketing of true cod species. The fishery began in California and moved north, where it is now concentrated in Washington, southeastern Alaska and the eastern central Gulf of Alaska. U.S. sablefish landings in 1985 were 64.5 million pounds valued at $28.7 million. Landings in Alaska increased by 74% in 1985 as compared to the previous year with 31.7 million pounds valued at $18.4 million. The 1985 sablefish landings climbed significantly as compared to previous years, being 69% higher than the average annual harvest for the period of 1980-84. Hence, in 1985 sablefish were considered for the first time to be a commercially utilized species in all areas of Alaska.

GEAR: Sablefish are captured by longlines and traps. Longline gear is preferred in areas such as Alaska where there are rocky bottoms, and fish caught on longlines are said to be superior in quality. Each longline vessel may have 10 to 20 "skates" of longline, each skate being 300 fathoms in length (1,800 feet). Therefore a vessel may operate between 3 to 5 miles of longline with up to as many as 5,000 hooks (Steiner pers. comm.). Vessels longer than 80 feet with a crew of ten can use as many as 25,000 hooks per day. These larger vessels, however, primarily operate farther from shore in the western Gulf of Alaska and freeze fish onboard. The southeast longline sablefish fishery is comprised of smaller vessels. Technological advances have changed the fishery in recent years toward using smaller hooks spaced closer together on the longline. Although longline gear varies among fishermen, in general hooks are spaced at 3-foot intervals.

AREA OF OPERATION: Sablefish are distributed along the North Pacific shelf from California to Alaska but the major area of distribution of this species is in the Gulf of Alaska at depths of 400 and 700 meters. During the winter sablefish are in the deepest water from 2,400 feet to over 72,000 feet. In recent years declining sablefish stocks have moved the fishery farther west into the Gulf, and exploratory fishing is being conducted west to 140-170 degrees West longitude. It is also becoming more of a year round and domestic, as opposed to foreign, fishery.

The State of Alaska institutes annual quotas on sablefish catches regulated by area and season. In Prince William Sound the fishery generally begins in April and ends when the quota is met usually around mid-June (Steiner pers. comm.). In the Bering Sea and Aleutian Islands the fishery begins in January.

LEVEL OF EFFORT: Since the inception of this fishery, demand for sablefish dictated the level of effort. Although harvest levels were at one time depressed, recent trends indicate increasing effort in this fishery. In 1981, approximately 100 vessels using longlines and two vessels using traps fished for sablefish in the Gulf of Alaska with over 80 percent of the catch taken by longlines (North Pacific Fishery Management Council 1984). Most sablefish fishermen are engaged in other fisheries during the summer.

INCIDENTAL TAKE/ENTANGLEMENT: The sablefish fishery in Prince William Sound, in the northern portion of the Gulf of Alaska, is presently threatening at least one identified "pod" or family group of 35 orcas (killer whales) (Steiner pers. comm.). The conflict has arisen because orcas are taking fish from sablefish longlines. Commercial fishermen, in retaliation, are shooting the whales.

Orcas in the Sound have been reported with circular wounds, indicative of bullets often passing completely through the dorsal fin. In 1985, out of the pod of 35 whales, eight whales had been wounded, five more had possible wounds, and three additional orcas were "missing" by fall 1985. Among the three missing whales, one had obvious bullet holes when last seen in spring. Therefore, out of the resident population of 35 whales in Prince William Sound that year, there was an 8.6 percent mortality rate, about 5 percent higher than previous years. There are presently six animals missing from the pod (Steiner pers. comm.). The conflict intensified with several fishermen using "Detadrive," a plastic explosive which is sometimes used during building demolitions, which is being exploded at a depth of 240 feet. Although the effect of explosives on orcas is not known, it may be damaging the sensitive inner ear of these whales.

According to the National Marine Fisheries Service (NMFS) over 700 fishermen operating in Alaska are permitted to take "small cetaceans" in the course of commercial fishing operations. But when questioned as to whether orcas can be classified as small cetaceans, NMFS reevaluated the permit and concluded that orcas were not included in the permit. Subsequently, NMFS prohibited the incidental take of orcas in this fishery and banned the use of explosives. However, some feel that enforcement will be difficult (Sierra Club National News Report 1986). Others are concerned over similar problems with marine mammals in the Bering Sea sablefish fishery.

The University of Alaska Marine Advisory Program has been experimenting with various methods to deter whales from taking bait and catch from longlines. Acoustic harassment devices and taste aversives used to date have shown little success. Lithium chloride has also been suggested as a taste aversive; this would make whales sick if they ate an injected fish so that whales might become conditioned not to interfere with fishing (Steiner pers. comm.). However, researchers are hesitant to try this because it is not known what dosage would be needed to make an adult whale sick without killing a younger (smaller) whale.

The most effective method to deter whales thus far seems to be for fishermen to pick up their longlines and move away from whales. However, the whales in Prince William Sound have been reported to recognize and follow the sound of a longline vessel as far away as seven miles (Steiner pers. comm.). The Japanese reported that they have had similar problems with whales since the early 1960's and the only method that appears to have worked is moving away. However, one group of whales followed a vessel for 180 miles (Steiner pers. comm.). One feasible alternative to this problem that has not been tried would be to require fishermen to use only troll or trap fishing gear for sablefish in areas where whales congregate (Steiner pers. comm.).

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Steiner, Rick. Sea Grant Agent, University of Alaska Marine Advisory Program, Cordova, AK.

Alaska Walleye Pollock Joint Venture Fishery

TARGET SPECIES: The walleye pollock, also known as the Alaska pollock, is a member of the cod family and has become of major economic interest, first abroad and now in U.S. markets as well. The high quality white fillet of pollock is used whole, in fish meal and for the production of surimi, a minced fish-meat product. A major use for surimi has devloped in the production of imitation crab legs. The consumption of surimi is expected to be 120 million pounds in 1986 - six times the amount consumed five years ago. Pollock roe is also of commercial importance.

In 1980 a joint venture fishery developed between U.S. vessels that caught and delivered pollock to Republic of Korea vessels for processing. This fishery targeted the enormous winter spawning schools of walleye pollock which aggregate in the Shelikof Strait-Simidi Islands region of Alaska. Joint venture pollock landings in this region for 1980 were approximately 950 metric tons (2.1 million pounds), which accounted for 50 percent of the total landings of pollock in joint venture fisheries within the entire Gulf of Alaska for that year. Since its inception the fishery has rapidly expanded; 17,000 metric tons (3.7 million pounds) in 1981, 131,390 metric tons in 1983, and 171,539 tons in 1984. The Republic of Korea has participated in this joint venture fishery since 1980. Japan participated in joint ventures throughout 1982-1984, and was joined by Poland and West German processing vessels in 1982 and 1984 respectively.

GEAR: Pollock fishing operations are conducted by U.S. vessels in the joint venture fishery using conical bag-shaped trawl nets that are pulled at mid-water depths between the surface and the ocean bottom. The depth at which the trawl is set is determined by where schools of fish are concentrated. Although fishing strategies and techniques vary, U.S. catcher vessels observed in this fishery have been reported to be over 100 feet in length and use very large trawl nets with a vertical opening of over 96 feet (West 1983). The mesh size of the trawls ranges from 48-inch mesh in the forward portion of the net and becomes progressively smaller to 4 3/4 inch mesh in the bag or codend section where fish are concentrated as the trawl is pulled through the water. In order to meet the demands of joint venture fishing the trawls are modified in various ways. The codend of the trawl is made to be detachable so that it can be transferred to the foreign processing vessel. When the trawl is pulled in after a tow the contents of the cod end are tied off, this section is detached, and will remain in the water alongside the vessel often for long periods of time prior to transfer and hoisting aboard the foreign processing vessel. Another modification in some trawls is a "blowout panel" that consists of longitudinal slits about four feet long cut into the webbing just forward of the codend. The panel is reinforced along the edges with nylon line and laced shut with light twine. When excessive quantities of fish are captured, which frequently happens in this fishery, these slits will break open releasing excess fish as the net is retrieved to prevent extensive gear damage or even loss of the codend.

The amount of time required to tow the net depends on when the net becomes full, which may vary between 5 minutes in extremely dense schools of fish to one hour in less favorable conditions. Haulback, or the time required to retrieve the net to the boat, usually takes 30-40 minutes.

Each catcher vessel generally makes several deliveries to a processing boat each day depending on the size of its net. A boat with a codend capacity of 50-60 metric tons (110-132 thousand pounds) of fish will make two deliveries per day whereas another with a 35-45 metric ton capacity (77-100 thousand pounds) will deliver three times a day. Since the foreign processing boat can accommodate only a limited number of vessels at one time the delivery of codends by U.S. vessels to the processor is timed so that a continuous supply of fish is available for processing 24 hours a day.

AREA OF OPERATION: Although joint venture fisheries are conducted both in the Gulf of Alaska and the Bering Sea, the Shelikof Strait fishery accounts for 40-50% of the annual joint venture harvest of this species. The stocks that congregate in this area in winter are dense and therefore easily harvested. In addition, since pollock spawn in this area in late winter and early spring, a high percentage of the females are valuable for their roe which is highly prized in Japan. The fishery in this area begins in January, peaks in late March and ends in March or early April.

LEVEL OF EFFORT: Each foreign processing vessel is served by 1-10 domestic catcher boats, depending on the capacity of the foreign vessel. In 1983, three Japanese and five Republic of Korea processing vessels were engaged in the walleye pollock joint venture fishery in Shelikof Strait. The number of U.S. vessels engaged in joint ventures with these countries was eight for Japan and 16 for Republic of Korea (Loughlin and DeLong 1983). This fishery is expected to expand in both the number of foreign and domestic vessels involved and the amount of fish landed.

INCIDENTAL TAKE/ENTANGLEMENT: The walleye pollock joint venture fishery in Shelikof Strait incidentally captures and drowns hundreds of northern (Steller) sea lions every year. During the period of 1982-1984 the number of sea lions incidentally captured by U.S. vessels ranged from 958-1,436 in 1982 to 237-355 in 1984 (Loughlin and Nelson 1986). During 1982 trawls with as many as 100 dead sea lions were reported. Joint venture fisheries have experienced 100% mortality of incidentally captured animals. These data were obtained from U.S. observers on foreign processing vessels who observed nets that were transferred to foreign vessels from U.S. catcher boats. Therefore these numbers of incidentally captured animals do not account for those animals that may have died and fallen out of the net through the blowout panel or were shaken out of the net by domestic vessel crews prior to transfer to the processor.

More than 90% of the sea lions incidentally captured were taken in nets fished over deep water near the Alaska Peninsula and toward the southwestern end of the strait. Seventy-three percent of the animals were taken in nets set during at night (2000 to 0500 hours) with 63% taken between 2300 and 0300 hours. Most of the animals were captured when the net was being retrieved and most were feeding almost exclusively on pollock.

The high level of mortality of incidentally captured marine mammals in this fishery is attributed to the practice of leaving the codend with the fish catch in the water for long periods of time prior to transfer to the processor, during which time sea lions that are incidentally captured drown. The reason for the decline in incidental take of sea lions over the period of 1982-1984 while fishing effort increased is not known. It has been suggested, however, that the high levels of incidental take during the earlier years of this fishery may have caused the sea lion population to decline, thereby leaving fewer animals to be captured (Loughlin and Nelson 1986).

Other explanations for decreased levels of take may be differences in fishing techniques, including the time of a tow, and differences in the time and location of the fishery each year. In addition, domestic fishermen, realizing the possible legal and economic implications of continued incidental catch of sea lions, may have avoided setting nets in areas of high sea lion concentration. The possibility that fishermen may be removing sea lions from nets before transferring the net to the foreign vessel is considered to be unlikely since it is difficult to remove an animal from a net containing 40-60 metric tons of fish. In addition, the net is usually not taken out of the water when the codend is detached, further complicating such removals. Small sea lions may be able to escape through the blowout panels that are now being installed in these nets.

Although the level of incidental take of sea lions in the walleye pollock fishery alone may not affect the Gulf of Alaska sea lion population, it may affect small local populations with the loss of sexually mature animals. Moreover, the incidental take of sea lions in the joint venture fishery, in combination with expansion of the domestic fleet (for which no records are maintained on incidental take), may have a cumulative impact. Recently, significant declines in the northern sea lion population in areas of Alaska such as the eastern Aleutian Islands have been noted and are cause for concern over the status of this species throughout its range (Loughlin and Nelson 1986).

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Alaska Groundfish Fisheries

TARGET SPECIES: The major groundfish species in the Gulf of Alaska and Bering Sea include Alaska pollock, Pacific cod, sablefish, Pacific ocean perch, halibut, turbot, flathead sole, rock sole and Atka mackerel. Among these species Alaska pollock, Pacific cod and halibut have been targeted most extensively and have yielded the greatest harvests. In 1985 the U.S. domestic Alaskan fleet harvested 92.8 million pounds of pollock and 104 million pounds of Pacific cod valued respectively at $5.3 million and $14.8 million. Halibut landings bring a greater price with nearly 54.5 million pounds landed in 1985 valued at $31.9 million.

The Alaskan domestic fishery has traditionally been overshadowed by the tremendous foreign fleets that operate off the coast. Four foreign countries participated in the groundfish fishery of Alaska in 1985. Japan has had the longest history of fishing in this region and has had the greatest effort over the years followed by the U.S.S.R, Republic of Korea and Poland.

The Japanese fishery developed into four principal components: the mothership fishery, the North Pacific trawl fishery, the North Pacific longline gill net fishery and the land-based trawl fishery. The mothership fishery has been the most extensive in terms of catch. It consists of a large ship that receives and processes catches supplied by a fleet of catcher vessels. Pollock has dominated Japanese catches since 1963. The North Pacific trawl fishery consists of factory stern trawlers larger than 500 tons that both catch and process their catch. From 37 to 57 trawlers have operated in recent years.

The total foreign catch in the Pacific Fishery Conservation Zone (FCZ) in 1985 was 1.1 million metric tons. More than 91% was taken in the eastern Bering Sea and 4% was taken in the Gulf of Alaska. Alaska pollock comprised 76% of the catch, followed by Pacific flounders (13%) and Pacific cod (6%). Japan and the Republic of Korea landed 92% of the foreign catch.

In recent years joint ventures have become of great importance in the Alaska groundfish fishery with U.S. vessels catching and selling their catch to foreign processing vessels. In 1985, 2 billion pounds of fish valued at $104.3 million was caught by all U.S. vessels participating in joint venture fisheries in the Atlantic and Pacific FCZ. This was a 37% increase over 1984 joint venture catches. Alaska pollock comprised 67% of the joint venture catch with nearly 1.4 billion pounds valued at $60 million dollars (U.S. Dept. Commerce 1986). Joint ventures are expected to eliminate all direct allocations to foreign fleets in the North Pacific by 1988-89 (Freeman 1986). Therefore, more U.S. vessels are expected to participate in joint ventures in the future. Most joint venture operations, however, do not eliminate the potential for a domestic vessel to fish on its own after a day's work.

GEAR: The major type of fishing gear employed in the Gulf of Alaska groundfish fishery is trawl nets. The size and type of fishing gear varies among different fishermen and countries operating off Alaska. Foreign vessels fishing in the Bering Sea use very large trawls depending on the size of the boat and the targeted fish species. For example, Korean vessels of 84 to 104 meters (275 to 340 feet) and up to almost 6 thousand gross tons operating in the North Pacific have been reported to use trawls with vertical openings of 6 to 38 meters (20 to 125 feet) (Bakkala et al. 1979). Some Japanese mothership vessels use even larger trawl nets (Nelson et al. 1981). In general the mesh of groundfish trawl nets ranges between 90-120 mm (3 to 5 inches). Domestic vessels typically have smaller nets although with the advent of joint venture fishing and the prospect for increased participation domestic vessels are becoming more numerous and larger. Trawl nets are towed along the bottom or at midwater depths depending on the location of fish concentrations. All fishing by the U.S.S.R. has been by trawls. Longlines and gill nets target herring and sablefish.

AREA OF OPERATION: The Bering Sea yields the majority of both domestic and foreign groundfish catches off Alaska. The major groundfish species, with the exception of sablefish, are found predominantly from inshore waters out to depths of 500 meters. Most of these species move inshore in summer and offshore in winter although the variation in depth may not change appreciably during migrations. Peak fishing activity in Alaska for both domestic and foreign fisheries is in June and July and the lowest activity is in winter.

LEVEL OF EFFORT: The most recent official information on number of domestic trawl vessels operating in Alaska is for 1977 when 86 otter trawl vessels for fish were registered in the state (U.S. Dept. Commerc. 1984). But the number has increased dramatically since this time. Vessels participating in joint venture fisheries alone numbered between 130-135 in 1985 (Freeman 1986). Moreover, future phasing out of foreign fishing in the FCZ will stimulate increased domestic operations. America's surimi fleet expanded its pollock operations in 1985 with seven vessels, one floating processor and six trawlers equipped with refrigeration. The number could double within a year (Johnson 1986). Conversely, the number of foreign trawlers fishing off Alaska has declined. In 1978 as many as 20 Japanese trawlers, 20 U.S.S.R. trawlers, 5 Korean trawlers and 5 trawlers from Poland operated in the Gulf of Alaska during any one month (Wall et al. 1981). The average number of all foreign vessels fishing off Alaska during the period 1978-1981 has ranged from over 500 in June and July to about 150 in December and January (Loughlin et al. 1983).

INCIDENTAL TAKE/ENTANGLEMENT: All foreign vessels operating in the FCZ of Alaska are required to have a general permit for the incidental taking of marine mammals. Under this permit, all vessels are required to report the taking of animals and a U.S. observer is stationed on board the mothership vessel to observe any incidental takes. Underreporting or misidentification of animals captured may affect the validity of the reports. Reports by U.S. observers may be more reliable but include only those animals actually seen and may not account for all those actually taken.

During the period of 1978-1981 a total of 298 incidentally taken marine mammals were observed by U.S. observers aboard foreign vessels in the North Pacific and Bering Sea FCZ. The total number of marine mammals expected to be killed by foreign fishing operations during this period was estimated at 724 animals per year. The primary fishery involved in incidental taking of marine mammals has been the eastern Bering Sea and Gulf of Alaska groundfish fishery. Trawl gear has accounted for most of the mortalities in this fishery. Japan has accounted for the greatest levels of incidental take, and Soviet vessels were second, which is not surprising since these countries have the greatest number of vessels in the area.

Among the animals that were incidentally taken in 1978-1981, 217 were dead; only 81 animals were released alive. Ninety percent (268) were northern sea lions. Sea lions are more likely to be captured since they often follow fishing vessels to feed on fish that are discarded from the net. Other animals incidentally captured include northern fur seals, harbor porpoises, ribbon seals and northern elephant seals. Incidental take of all marine mammal species occurs primarily from late summer through early spring. While fishing activity is greatest in spring and early summer incidental take is not as great at this time since most sea lions are at rookeries or feeding near shore, away from the foreign fisheries.

More recently, observers in the foreign North Pacific fisheries reported a total of 189 marine mammals taken during groundfish operations (Aron 1985). Again the majority of animals (132) were northern sea lions. The number of animals reported dead was 149 including 109 sea lions and 25 northern fur seals. Estimates of the total number of marine mammals reported dead was 228 with Japanese surimi operations taking the majority of animals.

Joint venture fisheries operating in the North Pacific FCZ in 1984 took more animals than foreign fleets during 1984: 347 animals, 333 of which were killed. Therefore a total of 575 animals were taken by foreign and joint venture fisheries in the North Pacific in 1984. The National Marine Fisheries Service currently permits foreign vessels operating in the U.S. North Pacific FCZ to take 580 marine mammals per year (U.S. Dept. Commerc. 1985). The Japanese/U.S. joint venture fishery took the majority of these animals; 185 northern sea lions were taken primarily during February and March in the area. For all vessels, from 1 to as many as 27 animals were reported taken in a single day.

Observers in joint venture fisheries are present only on foreign vessels and therefore report only those animals taken aboard foreign mothership vessels. These numbers do not account for animals that may have been taken by domestic catcher vessels but were not turned over to foreign ships. Moreover, while we have some indication of the level of incidental takes occurring in foreign and joint venture fisheries, virtually nothing is known about the level of takes by the increasing U.S. groundfish fleets that operate in the same areas with the same gear but have no observers. The National Marine Fisheries Service currently permits U.S. trawlers in the North Pacific to take 1,000 northern sea lions, 10 fur seals, 10 harbor seals, and 10 cetaceans. With an expanding fleet, the level of incidental takes will surely increase.

Perhaps an even greater problem associated with the intense fishing activity off Alaska, and other areas of the United States, is the entanglement of animals in pieces of fishing gear that have been discarded or lost. This problem is treated in more detail in a later section on entanglement in marine debris.

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Fisheries of Hawaii

Hawaiian Tuna Fisheries

TARGET SPECIES: The major species targeted by Hawaii's tuna fishery are yellowfin and bigeye tuna although albacore, dolphin (mahimahi), billfish, shark and other species are of economic importance to this fishery as well. The increased demand for fresh tuna on the mainland for sushi bars and Japanese restaurants has resulted in some expansion in this fishery in recent years. In 1985, approximately 11.2 million pounds of tuna was landed in Hawaii, valued at $8.6 million.

GEAR: Tuna are captured by three principal methods in Hawaii; longlines, handlines and trolls. Longlines were introduced to domestic fishermen by the Japanese and have proven effective in catching both tuna and billfish. Longlines consist of a mainline, which can be many miles long, to which branchlines are attached each with a baited hook. The gear is set early in the morning to drift for approximately six hours.

Longlines on smaller vessels are kept in baskets. Each basket may hold from 840 to 7,200 feet of longline with 6 to 13 hooks per longline. A boat may use 16-30 baskets of longline each day. Some of the newer boats use a continuous mainline of 46 miles with 1,500 hooks.

The handline fishery uses hooks on single heavy-duty lines that are handheld to capture fish. Handlines are categorized into two types: the palu-ahi and ika-shibi methods. Both methods are carried out on small vessels of 17-36 feet and are low in capital and operating costs but produce high catch rates.

The palu-ahi method, also referred to as the drop-stone method, is an antiquated Hawaiian fishing technique. The name is derived from the Hawaiian words "palu" meaning chum (a type of bait), and "ahi" referring to large species of tuna. Fishermen use a long heavy fishing line. The hook end is wrapped around a rock covered with pieces of chum and tied in a slip knot. The line, bait and rock are dropped over the side of the boat to depths of 75-150 feet. When the line reaches the desired depth it is jerked quickly to release the knot, thereby releasing the rock and spreading the chum around the baited hook to attract fish. This method is also conducted in schools of tuna associated with porpoises and in other areas where tuna are known to congregate.

The ika-shibi handline fishery is conducted at night. This fishery was developed by fishermen out of Hilo on the southeast coast of the island of Hawaii. The name "ika-shibi" comes from the Japanese words "ika" meaning squid and "shibi" referring to large species of tuna. Fishermen use the ika-shibi method to attract squid with a light at night for bait and then use the squid on handheld lines to catch tuna. While the fishery targets yellowfin, albacore and bigeye tuna, fishermen also benefit from the catch of other pelagic species. This fishery has expanded to the point that fishing grounds are overcrowded and efforts are underway to expand both the area and time of operation of this fishery, to relieve the crowding.

Troll fishing is a method in which hooks with bait or artificial lures are pulled through the water at the surface by a moving vessel. In addition to tuna, this fishing method attracts other economically important species such as billfish and mahimahi. There are essentially three categories of commercial troll vessels: 1) large west coast-style trollers originally used in the west coast and North Pacific albacore tuna fisheries, 2) medium-sized trolling vessels, and 3) small boats. The large vessels are divided between two fisheries, those transient in Hawaii, only passing through the Fishery Conservation Zone (FCZ) to and from the North Pacific albacore tuna grounds, and those that are based in Hawaii. The larger and medium-sized vessels normally troll four to six lines. Smaller vessels use two to three fishing poles and sometimes use additional handlines. Trollers use either artificial or fresh bait.

AREA OF OPERATION: Tuna longliners typically operate between 13-60 miles off the main Hawaiian Islands but at times range far offshore. Smaller boats travel some 15-50 nautical miles offshore, many remaining in sight of land but a few travel as many as 400 miles from the mainland. The palu-ahi handline fishery is conducted primarily off the west coast of the island of Hawaii. The ika-shibi night handline fishing out of Hilo is conducted at depths of 1,200 feet off the south point of Hawaii and has spread to the island of Kauai in recent years. Trolling is carried out throughout the Hawaiian Islands.

LEVEL OF EFFORT: The tuna longline fishery is currently in a stage of "renewed interest" and a number of modern vessels are entering the fleet. In 1984 at least 37 vessels were equipped with longline gear in Honolulu Harbor.

Night handline fishing boats range from 20 foot fiberglass skiffs to 60-foot boats, but most range between 22-28 feet. This fishery has been one of the fastest growing fisheries since 1973 because it uses small boats and inexpensive gear, yet a single night's work yet may bring as much as $1,000 in catch. In 1984 an estimated 170 vessels operated in Hawaii and grossed approximately $4 million in 1984. Although a more recent estimate of the day handline fishery is not available, in 1979 an estimated 100 fishermen operated in the fishery (Hawaii Dept. Land and Nat. Resourc. 1985).

In 1976 there were approximately 10-15 large albacore troll vessels and approximately 160 small troll vessels in Hawaii. It is diffiult to estimate more recent numbers of vessels in the state, but in 1982 a mail survey of fishing vessels in Hawaii indicated that 4,765 respondents (46 percent) of commercial and recreational fishermen in the state considered troll fishing gear and rod and reels to be the most important fishing gear used (Hawaii Dept. Land and Nat. Resourc. 1985).

INCIDENTAL TAKE/ENTANGLEMENT: Although no mortalities of marine wildlife have been directly attributed to the tuna fishery, both sea turtles and cetaceans are known to interact with commercial tuna fisheries in Hawaii. Sea turtles have been reported either entangled in longline gear or actually hooked on occasion. However, since the level of incidental take has not been quantified it is difficult to determine the impact of this take (Balazs pers. comm.).

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Several species of cetaceans have been reported to take bait and damage or take fish caught in the longline, handline and troll fisheries for tuna. The two principal fisheries involved are the tuna handline and trolling fisheries. In Oahu the night handline fishery has experienced conflicts with Pacific bottlenose dolphins. Around the main island of Hawaii, the troll fishery has involved interactions with Pacific bottlenose dolphins and false killer whales. Here, fishermen also troll for billfish using tuna as bait and have experienced dolphins and whales trying to take the bait as well as the catch. In Kona the daytime handline fishery has reported conflicts with Pacific bottlenose dolphins and rough toothed dolphins (Henderson pers. comm.).

In the early 1980's fishermen indicated that the incidence of interaction had increased substantially to a point where dolphins were being blamed for substantial economic loss. At this time researchers began to experiment with several techniques to deter porpoises from fishing gear. However, a successful method has not been found (Nitta pers. comm.). Fishermen reportedly have tried their own methods of deterrents including poisoning and shooting (Gilmartin pers. comm.). Reports have been received of fishermen putting hooks, chili pepper and Drano in fish (Henderson pers. comm.). Although fishermen have been reported to shoot at the animals only as a scare tactic and no mortalities have been reported, the problem has not been investigated first hand. Management agency personnel (Seigleri pers. comm.) have suggested killing the individual dolphins that actually steal the fish, assuming that the other dolphins would be deterred from learning similar behaviors. Although stealing bait and fish from fishing gear is apparently a learned behavior, there is no way of telling how far this behavior has already spread through the population, or whether other animals would be deterred from learning it.

Apparently the number of reports of interactions has decreased recently compared to previous years, although the reason for this is unknown (Gilmartin pers. comm.). However, since these interactions have not been investigated it is not known if the reason for fewer reports is due to the fact that the problem has diminished or if fishermen have found ways to deal with this problem (Henderson pers. comm.). Further study is needed to determine the extent of interactions and level of mortality that occurs in this fishery.

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Seigleri, Lou. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, Honolulu, HI.

Hawaiian Bottomfish Fishery

TARGET SPECIES: The bottomfish fishery targets members of the snapper-grouper-jack complex which includes snappers, sea bass and jacks and amberjacks. About 20 species are landed commercially in significant quantities.

Commercial bottomfish landings for the period 1978-1982 have ranged between 500,000 and 700,000 pounds valued at $1 million per year (Hawaii Dept. of Land and Nat. Resourc. 1985). Record high levels of catch have been recorded most recently with 2.5 to 3 million pounds in 1984 (Western Pacific Fishery Management Council 1986).

GEAR: The fishery depends primarily on catches taken by hook and line fishermen and to a lesser degree by longline and trap fishermen. The handline fishery uses the basic fishing gear of a hook and a line. To each line four or five baited hooks are attached. The line is lowered over the side of the boat for a period of time and then retrieved. Some fishermen haul lines in by hand and others use automated line haulers.

AREA OF OPERATION: The Hawaiian Islands do not have the extensive continental shelf of the mainland U.S. that supports a wide diversity of fisheries. The islands are volcanic peaks with steep dropoffs and limited shelf ecosystems. Therefore, primary fishing grounds are limited because only a narrow portion of the ocean satisfies the depth requirements of most bottomfish. Deepwater snapper and grouper are found in the boundary between the narrow terraces and deep slopes that surround these islands at depths of about 600 feet. Other bottomfish species are less restricted to particular depths and may range throughout the water column ranging from 90 to 900 feet (Western Pacific Fishery Management Council 1985).

Bottomfish populations are not evenly distributed but are found in pockets. Once these pockets are discovered they are heavily fished which can result in reduced stocks within a relatively short period of time. As catches of large older fish decline fishermen move on to new areas.

Until a few years ago the fishery was conducted primarily around the main Hawaiian Islands with the major fishing area spreading throughout the Hawaiian Island range from Hawaii to Nihau. Recently long-range vessels equipped with several types of fishing gear have entered the fishery and are able to go further distances to more productive fishing grounds in the Northwestern Hawaiian Islands where many of the smaller mainland vessels can not go. Major bottomfishing areas in the Northwestern Hawaiian Islands include areas surrounding Kure Island, Midway Island, Lisianski Island, Laysan Island, the French Frigate Shoals and several offshore reefs and banks. In the FCZ, the major fishery for bottomfish is in the Northwestern Hawaiian Islands 250-1,260 nautical miles (463-2,333 km.) from Honolulu.

There has been recent interest expressed in developing a mothership fishery based in the French Frigate Shoals near Tern Island to support a small multi-purpose catcher vessel fleet (Hawaii Dept. Land and Nat. Resourc. 1986). The catcher vessels would target bottomfish as well as lobsters and deep sea shrimp and the mothership would recieve catches and provide supplies.

LEVEL OF EFFORT: The main Hawaiian bottomfish fishery has consisted of about 100 full-time vessels and perhaps as many as 1,000 part-time vessels. The northwestern fishery is conducted by approximately 20 vessels (Western Pacific Fishery Management Council 1985).

INCIDENTAL TAKE/ENTANGLEMENT: The Hawaiian monk seal occurs in a limited area around the Northwestern Hawaiian Islands. The monk seal is a critically endangered species with perhaps as few as 1,200 individuals remaining. As stated above, the Hawaiian bottomfish fishery is currently expanding into this area due to diminishing bottomfish stocks near the main island and the recent participation of larger vessels that can travel farther from the mainland to the Northwest Hawaiian Islands.

In developing a Fishery Management Plan (FMP) for the bottomfish fishery, the Western Pacific Fishery Management Council determined that the fishery would not pose a threat to monk seals. The Marine Mammal Commission noted, however, that the determination was not based on any apparent documentation. In view of the Commission's comments, the Council appears to have arrived at a compromise. Fishermen are permitted to fish in the area while scientists from the National Marine Fisheries Service evaluate any effects of the fishery on Hawaiian monk seals. However, since there is not an observer program in this fishery, information on interactions is obtained only by fishermen. And since the harassment or incidental takings of monk seals are illegal, a reporting system based on fishermen's accounts would seem to be somewhat questionable.

Current information indicates that Hawaiian monk seals at French Frigate Shoals have been observed taking fish off hooks and damaging fish caught (Western Pacific Fishery Management Council 1986). Although mortality of monk seals due to this fishery has not been documented, Henderson (1985) reported a monk seal that was observed at French Frigate Shoals with a fish hook in its lower lip. The hook was the type used in the bottomfish fishery and appeared to have resulted from the seal's encounter with actively fished gear. According to an official with the National Marine Fisheries Service a fisherman recently reported that monk seal pups appear to be curious about fishing vessels and swim up to them (Seigleri pers. comm.). Although these pups have not been reported to interfere with fishing gear, some fishermen are hitting monk seals over the head (Gilmartin pers. comm.). One report was received of a fisherman that shot at a seal but further investigation into the incident was not possible (Henderson pers. comm.).

According to a representative with the National Marine Fisheries Service in Hawaii, although fishermen are given a one-page informational sheet on the importance of protecting monk seals and are told that they should report any incidental takes, including harassment, currently available information is insufficient to provide a thorough understanding of the magnitude of Hawaiian monk seal interactions with the bottomfish fishery (Gilmartin pers. comm.). The Marine Mammal Commission has suggested that one way to determine what interactions occur would be to charter a bottomfishing boat, and fish in the same areas using the same gear as commercial fishermen (Gilmartin pers. comm.).

The Marine Mammal Commission has also expressed concerns over the proposed development of a commercial mothership fishery based in the French

Frigate Shoals since this area is critical habitat for the Hawaiian monk seal. Depth restrictions in which fishing would be prohibited have been proposed as a way to prevent interactions (Marine Mammal Commission 1986).

Pacific bottlenose dolphins have also been reported to take bait and catch from bottomfish fishing operations in both the main and Northwestern Hawaiian Islands (Henderson pers. comm.). However, the extent of these interactions has not been documented.

Sea turtles may also be involved in interactions with the bottomfish fishery by swimming into the gear and becoming entangled (Western Pacific Fishery Management Council 1985). Although two of the four species of sea turtles that occur in the area of the bottomfish fishery are listed as endangered (hawksbill and leatherback) and two are listed as threatened (green and olive ridley), bottomfish fishermen have been granted the permission to kill these animals incidentally under section 7 (b)(4) of the Endangered Species Act. The National Marine Fisheries Service has authorized an acceptable level of mortality incidental to fishing operations.

Since there is no documentation of sea turtle incidental take by bottomfish hook-and-line gear NMFS concluded that the expected take by allowable gear under the bottomfish FMP is "negligible, if any." Consequently, NMFS set the acceptable levels of incidental take at five individuals each of hawksbill, leatherback, and olive ridley sea turtles and 15 green sea turtles. Of these mortality may not exceed two animals of each species. They also stated that "the terms and conditions that must be complied with are the date of take and accounts of mortality must be provided to the NMFS" and "every effort must be made to return the turtles to the sea alive, with as little harm as possible." NMFS proposed to review the reports and other available information on an annual basis to determine whether the incidental take level should be modified or if other management measures will need to be instituted.

Again, however, while fishermen are required to report any incidental taking in this fishery, there is no observer program to substantiate the validity of reports. The National Marine Fisheries Service (NMFS) appears to be relying only on information supplied by fishermen to determine if this fishery presents any threat to turtles. No reports have been received to date. Although officials with NMFS believe that it is unlikely for turtles to take baited hooks because they are set at great depths (Seigleri pers. comm.) sea turtles may encounter hooks as they are being set or retrieved at the surface. Sea turtles also have a distinct propensity for entangling their flippers and heads in rope (Balazs 1985). Therefore, entanglement in handlines could likely occur.

The Western Pacific Fishery Management Council Program Office (Nitta pers. comm.) views the permitted mortality levels as a means of protecting fishermen so that they may continue to fish. However, it appears that nothing is being done to monitor and protect the sea turtles that may be involved in these interactions and whose status is either threatened or endangered.

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Other Pelagic Fisheries

High Seas Driftnet Fisheries

TARGET SPECIES: Large foreign drift gill net fisheries operate in the North Pacific targeting salmon, squid and billfish. Salmon are anadromous species that migrate from the ocean to spawn in fresh water and then return to the ocean to mature, thus completing the cycle. While salmon support major coastal and inshore fisheries in the U.S., Japan is the only nation with a high seas fishery for salmon.

Traditionally, Japan has had the most extensive high seas fisheries comprised of four drift gill net fisheries in the North Pacific: a land-based salmon fishery, a mothership salmon fishery, a billfish and tuna fishery, and a recently developed squid fishery. Taiwan and the Republic of Korea also have squid drift gill net fisheries in the North Pacific.

Although the majority of salmon caught by the Japanese fleet are of Soviet origin, it is estimated that they intercept and catch about one million North American salmon each year. Since older salmon feed on squid offshore, the foreign high seas squid fisheries also incidentally intercept North American salmon (Gordon 1985). In addition, it is estimated that 50 percent of all fish ensnared in gill nets die and drop out of the nets before they are retrieved thereby resulting in a tremendous waste of potentially harvestable fish for both U.S. and foreign fisheries (Goodman 1985). Factors such as these have led to regulatory actions directed at foreign fisheries in order to conserve North American salmon stocks.

GEAR: Gill nets used in the salmon and squid fisheries are single strand monofilament that range from 9 miles long in total length in the Japanese salmon mothership fishery to 14-20 miles long in the squid gill net fisheries of Japan, Taiwan and Korea. Nets are designed to be invisible to fish but are indiscriminate in terms of catch, entangling anything that is not small enough to pass through the mesh. A total of 20,500 miles or more of drift gill net is set every night by these nations during the fishing season for salmon, squid and billfish for a total of over 1 million miles of net per year (Eisenbud 1985).

The mesh size of these drift gill nets ranges from 110 mm to 130 mm stretched mesh. Japan's mothership fishery uses nets of 121-130 mm and the land-based fishery uses nets of 110 mm minimum mesh size with 115 mm being most common. The squid fisheries use mesh sizes of 115-120 mm for Japan, 96-110 mm for Korea and 90-115 mm for Taiwan.

The billfish fishery of Japan uses multifilament nylon nets that range from 170 to 180 mm stretch mesh with smaller mesh nets of 160 mm used in some Taiwanese sailfish fishing operations.

The Japanese mothership fishery is perhaps the most complex fishery of the world. It consists of several enormous factory ships that process salmon brought to them by a fleet of catcher boats. Twenty-four of the catcher boats are scout boats that continually search for new fishing grounds. Since scout boats frequently fish far from the mothership, their salmon catch is often salted and stored onboard. The remainder of the catcher boats return to the mothership each day.

Each catcher boat uses a single 9-mile-long net, approximately 20 feet deep, that is made from 330 tans (a tan is a fifty-meter section of net) that are laced together end to end. At two equally spaced intervals in the net the tans are only tied together at the top of the net instead of being entirely laced together. This separates the entire net into three panels which are designed to break apart in moderate to rough seas to prevent tangling. Each section is marked with radio buoys to aid in its relocation. The beginning and end of the entire net is also marked with additional aids such as light buoys, flags and radar buoys.

The gill nets are set to drift at night. Each catcher boat is positioned in an orderly array and all nets in a fleet are set parallel. In early morning the nets are retrieved, usually after they have been drifting for 11-12 hours. The catcher boat then returns to the mothership to offload its catch of salmon and other species and to take on additional supplies and fuel.

Vessels in the relatively new Japanese squid fishery, which began in 1978, use 115-120 mm monofilament gill net. Squid boats each use 18-19 miles of net, each net being set 10 meters deep every night (Campbell 1985). However, very little information is available about the operational aspects of Japan's squid fishery or those of Taiwan and Korea.

AREA OF OPERATION: The range of the foreign high seas drift gill net fisheries in the North Pacific extends over 4,000 miles east to west (from the Soviet Union's Fishery Conservation Zone (FCZ) to Cordova, Alaska) and 600 to 1,500 miles north to south (Campbell 1985). The Japanese mothership salmon fishery is the only foreign drift net fishery operating within U.S. waters.

The location of the Japanese salmon mothership and land-based fisheries are regulated by the International North Pacific Fishery Commission (INPFC), the organization established to regulate the North Pacfic salmon fishery and to ensure the conservation of North American salmon stocks, and by a Japanese-Soviet fisheries agreement.

The mothership salmon fishery operates north of 46 degrees North between 170 degrees East and 175 degrees East in the central Bering Sea. The land-based salmon fishery operates south of 46 degrees North and west of 175 degrees East. The billfish and tuna fishery operates north of the Hawaiian Islands Fishery Conservation Zone (FCZ), and the squid fishery occurs in the central and western North Pacific. Taiwan and the Republic of Korea are not members of the INPFC and therefore have unregulated fisheries.

The mothership fishery operates primarily within a narrow band of the U.S. FCZ during June and July. Outside the FCZ more than 2,000 nets are set by the Japanese salmon mothership fishery (Forsell pers comm.).

The Japanese land-based salmon fishery operates south and west of the mothership fishery with 80 percent of the fishing effort north of 42 degrees North latitude and between 155-175 degrees East longitiude. It operates from May to mid-July.

The Japanese squid fishery operates from June to December and encompasses a large area north to 40-46 degrees North latitude and within 170 degrees East and 145 degrees West. Peak catches are in July through September. This fishery has been regulated since 1981 by time and area closures to protect North American salmon stocks, but numerous violations of these regulations have been reported (Gordon 1985).

The areas of operation of the Taiwan and Republic of Korea squid fisheries in the North Pacific are unrestricted. The squid fishing season of Taiwan in the northwestern Pacific begins in mid-April and extends through November. Eighty to ninety percent of the squid catches are made from July through October. Since 1983 the Taiwanese fishery has operated between 33-46 degrees North latitude and from 155-160 degrees West longitude. The Korean squid season is from May to January. The area fished is currently between 34-47 degrees North latitude and 141-161 degrees West longitude. Although in 1984 Taiwan promulgated regulations that prohibited both fishing for salmon on the high seas and exporting salmon products from Taiwan, reports of squid vessels taking high levels of salmon persist as do reports of Taiwan salmon products marketed in other countries (Gordon 1985).

LEVEL OF EFFORT: The salmon mothership fishery consists of four motherships and 172 catcher boats. In 1983 and 1984 the level of fishing effort for the Japanese salmon mothership fishery was 8,395 and 9,121 sets respectively (Lambertson 1985). The total annual fishing effort since 1978 has been approximately three million tans (93,208 miles) (Jones 1985). The majority of this effort has been conducted within the U.S. FCZ.

The land-based salmon fishery uses more boats and nets than the mothership fishery and presently has approximately 210 drift gill net vessels (Wolfe 1985). The annual fishing effort of the land-based fishery since 1978 has ranged between 2.3 million to 3.4 million tans (71,460 to 105,636 miles) (Jones 1985).

In comparison to the salmon fishery, the foreign squid fisheries are even more extensive with drift gill nets that are twice as long and many more vessels involved (King 1985). In 1983 Japan had approximately 534 squid gill net vessels operating in the North Pacific that fished a total of 41,980 boat days. Since each fished with a gill net 18-19 mile long, the total amount of net fished that year, assuming all nets were fished each night, was 761,000 miles long - enough to reach three times from the earth to the moon and back with enough remaining to wrap five times around the earth (Campbell 1985). The total number of operations for 1984 was even greater, with 57,014 boat days (Fisheries Agency of Japan 1985).

Nearly 250 additional vessels participate in the squid fisheries of Taiwan and Korea. Taiwan vessels numbered 12 in 1980 and increased to 146 in the 1984 fishing season with an estimated annual harvest of several thousand pounds (Wolfe 1985, U.S. Dept. Commerce 1986). In 1984 Taiwan conducted 11,389 gill net operations using an average of 20 kilometers of net (12 miles) for a total of 136,668 miles of net set that year. The Republic of Korea squid fishery began with 10 boats in 1980 and has increased to 100 boats in 1983-1984 (U.S. Dept. Commerce 1986). In 1983 the squid fishery of Korea had 7,560 operations using an average of 27 kilometers of net (16.8 miles) for a total of 126,838 miles of gill net set this year (U.S. Dept. Commerce 1986).

The Japanese drift net fisheries for billfish had 600 vessels in 1983 which fished year round. Of these, 140 vessels operated east of 170 degrees East and conducted 5,600 operations throughout the year using a total of 65,520 kilometers of net (40,713 miles) and the remaining operated west of 170 degrees East with 13,800 operations using 124,200 kilometers of net (77,176 miles) (Shima 1985).

INCIDENTAL TAKE/ENTANGLEMENT: Thousands of marine mammals and seabirds are reported killed in drift gill nets used by the North Pacific foreign fisheries every year. Thousands more die but are never reported because of the lack of any observer program. Information on incidental take in these extensive fisheries is very sketchy. The most complete data come from the Japanese mothership salmon fishery operations within our FCZ. This is the only fishery with U.S. observers aboard.

Since 1978 the annual incidental take of Dall's porpoise by Japanese salmon land-based and mothership fisheries has been reported to the INPFC by the Japan Fisheries Agency. In 1981, under a permit issued to the Japanese mothership fishery to take marine mammals in U.S. waters, an annual quota of 5,500 Dall's porpoise was established. This permit is being renegotiated for 1987 and beyond (see legal section).

The reported incidental take of Dall's porpoise ranged from 499 in 1978 to 3,189 in 1982. Based on the total fishing effort for the entire fleet the estimated number of Dall's porpoise taken by the Japanese salmon mothership fishery for 1981 to 1983 ranged from 2,862 in 1981 to 5,903 in 1983. In 1985, the estimated number of Dall's porpoise killed in this fishery was 3,239 but may have been as high as 4,349 animals (U.S. Dept. Commerce 1986). The majority of animals (65-85 percent) over the past few years have been caught in the U.S. FCZ. In addition to Dall's porpoise, the Japanese salmon mothership fishery alone kills 400-1,000 northern fur seals every year within the U.S. FCZ.

The Japanese land-based salmon fishery reported incidental takes of Dall's porpoises ranging from a low of 127 animals in 1979 to a high of 1,641 in 1982. Based on total fishing effort the total estimated number of Dall's porpoise taken in this fishery has ranged from 2,961 in 1981 to 6,099 in 1982. Therefore the Japanese mothership and land-based fisheries incidentally captured a total of 5,828 Dall's porpoise in 1981 and 12,002 in 1982. Other species incidentally taken in fewer numbers include harbor porpoises, northern right whale dolphins, Pacific white-sided dolphins, common dolphins, northern sea lions and northern fur seals.

The numbers of seabirds incidentally taken in Japanese salmon fisheries is significantly greater. An annual average mortality of 163,000 seabirds is reported killed each year in the mothership fishery alone; in some years, mortality has reached almost 250,000 (Lambertson 1985). These numbers do not account for those birds that die and drop out of the net without ever being observed which may be as high as 13 percent (Ainley et al. 1981). Again, the large majority of this kill occurs within the U.S. FCZ.

While 21 species of seabirds are taken in Japanese gill nets, the majority of seabirds incidentally killed are of two species, the short-tailed shearwater and the tufted puffin. In some years the catch of short-tailed shearwaters has accounted for approximately half of the total seabird catch. Shearwaters are migratory species that breed in the southern Pacific and migrate through the North Pacific. Populations move in and out of the gill net fishing area during the summer so that large numbers of birds can occur within the area throughout the fishing season. Since shearwaters feed in groups a single bird can lead hundreds of others into a net. It is estimated that 27 percent of the tufted puffin population in the U.S. FCZ is killed in an average year (King 1985).

Catch rates of seabirds increase dramatically in areas where they breed. In the western Aleutians, where there are large nesting colonies, catch rates increase as distance to the islands decreases and catch rates decline out beyond 60 nautical miles. Catch rates of birds are highest south of the Aleutians, where fishing effort is concentrated. Most of the breeding birds taken in this area are alcids (puffin relatives). For some species, a significant percentage of the take consists of breeding age animals; 8.7% of the breeding population of tufted puffins is estimated to be killed in the mothership salmon fishery (Lambertson 1985). Therefore, fishing in the area of seabird nesting colonies could be adversely affecting local U.S. breeding populations of seabirds.

While most of the incidental take data come from observations of Japanese mothership fishing operations within our FCZ, very little is known about fishing operations outside U.S. waters. Almost no information is available on the mortality attributable to the 2,000 additional nets in the mothership fishery set outside the FCZ. The little information available indicates that seabird catch rates are higher in the fishing area south of the FCZ than north of the FCZ. It is also estimated that the take of seabirds by the land-based fishery is equivalent to that of the mothership fishery (King 1985).

Practically nothing is known about the incidental take of marine mammals and seabirds in the squid drift net fisheries since these operations are conducted outside the U.S. FCZ. In comparison to the mothership salmon fishery, however, the effort of these fisheries is significantly larger and the nets used about two times longer. Mesh size is similar to that of the salmon nets. Since seabird mortality has been found to be greatest in nets within the range of 106-138 mm stretched mesh and all drift gill nets used by the Japanese, Taiwan and Korea squid fisheries fall within this range, it may be expected that these fisheries also take high levels of seabirds (Ainley et al. 1981). The species most likely to be affected by fisheries operating outside our FCZ are shearwaters. The peak of the Taiwanese and Japanese squid season from summer into October occurs during shearwater migrations. Although densities of birds are not as great as these to within the U.S. FCZ, the greater fishing effort in these fisheries could offset lower catch rates (King 1985).

Fishing effort for squid is high within the range of the Dall's porpoise and therefore incidental takes of this species are probably comparable, and most likely greater than that of the mothership fishery (U.S. Dept. Commerce 1986).

In 1979 Japanese fishing vessels began using driftnets to catch squid northwest of the Hawaiian Islands, in international waters between 35 degrees and 45 degrees North. According to Balazs (1982) this fishery poses a threat to leatherback turtles in their North Pacific feeding grounds and migration routes. The existence of leatherbacks in this area has only recently been discovered and reported.

Essentially nothing is known of incidental takes in the foreign billfish fisheries conducted north of the Hawaiian FCZ boundary. However, a 140-foot Japanese gill net vessel was found illegally hauling in a net approximately 20 miles inside the FCZ near Hancock Seamount. The vessel's catch log indicated that it had taken 69 porpoises (Western Pacific Fishery Management Council 1986).

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Forsell D.J. Alaska Office of Fish and Wildlife Research, U.S. Fish and Wildlife Service, Anchorage, AK.

U.S. Tuna Purse Seine Fishery

TARGET SPECIES: Tuna are distributed throughout the world's oceans engaging in very long migrations even across the breadth of the entire Pacific Ocean. Primary factors that regulate tuna concentrations within particular areas of the ocean are oxygen and temperature. In the eastern Pacific Ocean, tuna are concentrated in a shallow water layer where conditions are optimal.

About two-thirds of the world's tuna are harvested from the Pacific Ocean. The Atlantic Ocean produces about one-quarter of the world catch with the remainder coming from the Indian Ocean. The world tuna catch in 1984 was estimated to be 1.78 million metric tons, up 3 percent from 1983. The U.S. consumes about 50 percent of this amount, and Japan and western Europe about 45 percent.

The Pacific tuna fishery began in California at the turn of the century when albacore were canned commercially. The market for canned tuna grew significantly after the discovery that smaller tuna, particularly the yellowfin and skipjack, were also excellent for canning and provided a cheap protein staple of the American diet. Consequently, the tuna fleet increased rapidly and the fleet moved further offshore. By 1930 it extended to the Galapagos Islands. The U.S. tuna fishery now depends primarily on four species of tuna: yellowfin, skipjack, bluefin and albacore. The yellowfin and skipjack tuna are found predominantly in the tropical oceans and constitute the bulk of the tuna fishery catch. In the eastern tropical Pacific (ETP), yellowfin and skipjack make up 62 and 38 percent of the average annual U.S. purse seine catch respectively. Bluefin and albacore are found in more temperate regions.

GEAR: Initially tuna fishing technology consisted of chumming, whereby bait is thrown into the water to attract fish, carried out by bait boats equipped with fishing poles, and longlines. As early as 1914 tuna fishermen experimented with nets to increase catch. Purse seine nets made of cotton proved to be most successful and became widely accepted in the fishery. In the 1950's, however, Amercian tuna fishermen were faced with growing competition from the Japanese fishery which employed a different fishing method. Using a fleet of longline catcher boats and a mothership processing vessel, the Japanese fishery employed longlines that stretched over 50 miles of ocean, catching significant amounts of tuna. The system was so efficient that American fishermen were pressed to improve their own method of fishing to save the U.S. market.

Two technological developments were of great importance to the modern U.S. tuna fishery: the introduction of large strong nylon nets of 10.8 to 11.4 cm stretched mesh that did not decay like cotton nets in warm tropical waters and therefore required less maintenance; and development of a powerblock, a mechanical hauling device that could retrieve immense purse seines faster, thus enabling each boat to make more sets and catch more fish each day. Subsequent developments of shore-based cold storage facilities in Central America and refrigeration on ships enabled fishermen to catch fish far from port. This combination rapidly led many fishermen away from traditional pole and longlining systems to purse seining and was the advent of large-scale distant water purse seine fleets.

Ever since the inception of the tuna fishery, fishermen recognized that schools of tuna were commonly associated with drifting logs or other floating objects and "log-fishing" as it is termed became a major way of fishing. But with the advent of large-scale distant water purse seining fleets it was observed that porpoise and tuna, especially yellowfin, swim together in waters off Central America.

In the 1960's a new method of fishing was developed to take advantage of the tuna/porpoise associations. When a school of porpoise has been sighted high-powered speed boats are deployed from the mothership to chase and slow the porpoise herds while the mothership catches up. As the mothership approaches the herd the skiff is launched to set the net in a circle around the dolphins. The skiff then acts as an anchor as the larger vessel maneuvers the net to encircle the school of tuna. When the vessel nears the skiff at the completion of the circle both ends of the net are attached to the power block. The net is then closed at the bottom or "pursed" by winching in a cable that runs through rings attached around the bottom of the net closing like a drawstring. The catch is then trapped and retrieval of the net commences. Modern nets may be nearly one mile in length and 450 feet deep.

This method of fishing, termed "porpoise fishing," has made purse seining more effective and greatly improved the economic performance of tuna harvesting.

At present about half of the landings of yellowfin tuna caught in the ETP by the international fleet comes from porpoise fishing. The U.S. fishery in the eastern tropical Pacific takes an average of 57 percent of the world's harvest of yellowfin tuna. Sixty-five percent of this catch comes from purse seines that have been set on schools of porpoises (U.S. Dept. Commerce 1986).

Once the net is set, schools of porpoises inside the net stay relatively motionless. During net retrieval, attempts are made to release the porpoises. When roughly three-quarters of the net has been pulled onto the mothership, the vessel manuevers to bring the remaining portion of the net into a long oval shape in which the porpoise and tuna are trapped at the farthest point from the ship. The vessel then shifts into reverse, and the net dips underwater, which provides an open passage for porpoises to escape. This is called the "haul-back" position. If tuna appear to head toward this opening as well the boat will stop temporarily causing the top edge of the net suspended by floats to come to the surface blocking the passage. Although not all porpoises instantly take advantage of haul-back maneuvers, tuna will. Sometimes many tons may escape within minutes. The haul-back maneuver can be repeated many times until all or most of the porpoises are released.

AREA OF OPERATION: Tuna are caught in temperate and tropical waters of all major oceans but two-thirds are harvested in the Pacific. The major area of operation of the U.S. tuna purse seine fishery is in the eastern tropical Pacific within 5 million square miles of ocean between 40 degrees North and South latitude and east of 160 degrees West longitude.

LEVEL OF EFFORT: In 1984, the international tuna fleet consisted of 213 vessels that operated in the eastern tropical Pacific during all or part of the year with a total carrying capacity of 116,412 short tons. Of these, 164 vessels were purse seiners. The U.S. tuna fleet was the largest component of the world's fleet with 106 vessels. Mexico was second with 43 vessels and Equador with 35 vessels was third. By mid-1985 there were 103 purse seine vessels in the U.S. with an aggregate capacity of 108,546 short tons.

Only a portion of the U.S. fleet operated in the eastern Pacific. Thirty-seven vessels were operating during the first quarter of 1984 having a carrying capacity of 25,150 tons. The number increased by the end of the year to 58 vessels (39,623 tons) due to improved fishing conditions to U.S. vessels active in the western Pacific numbered 61 at the beginning of 1984 declining to 43 at the end of the year. Four vessels having a combined capacity of 4,780 tons fished in the Atlantic.

INCIDENTAL TAKE/ENTANGLEMENT The tuna/porpoise issue is perhaps the best known marine mammal--fishery conflict in history. Current technology involving setting on porpoise cannot prevent the entanglement and subsequent drowning of many thousands of porpoises each year. Some become entangled in folds of netting and are unable to free themselves. Others may remain hidden and are not visible to fishermen until after the net has been hauled into the boat. These and other factors contributed to the significant porpoise mortality rates caused by the U.S. tuna fishery. In the early 1970's concern mounted over the numbers of porpoises that were incidentally killed during fishing operations. In 1971 porpoise mortality or serious injury caused by the international purse seine fleet was 261,928. The U.S. fleet was responsible for 246,213 or 94 percent of these incidents. The following year this number increased to 423,678 with U.S. purse seiners taking 368,600 porpoises in their nets. That year, 1972, also marked the U.S. passage of the Marine Mammal Protection Act (MMPA), which mandated zero porpoise mortality. Three to five million porpoises had been killed during the twelve years prior to its enactment (Minasian 1977).

Thirteen species of porpoises and small whales are involved in interactions with the tuna fishery in the eastern tropical Pacific Ocean but four species are most commonly taken: the spotted dolphin, common dolphin, striped dolphin and spinner dolphin. Spotted dolphins are most commonly taken with over 3 million killed per year in the international fishery in the early 1970's.

With the passage of the MMPA the U.S. tuna industry looked as if it would be severely affected. The industry argued that it was already working on ways to solve the porpoise problem. One was the inclusion of the Medina panel--a small mesh (1 1/4 inch) section of netting that was placed in the net where the dolphins congregate. It provides a horizontal channel to guide porpoises toward the opening and reduce entanglement that can occur in the larger mesh areas of the net. This is now required on U.S. vessels and some foreign vessels. Congress gave the industry a two-year grace period. The ultimate goal was to reduce porpoise mortality to "insignificant levels approaching zero." Subsequently, lower quotas were set and additional regulations promulgated.

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However, the MMPA still allows the taking of thousands of porpoises by the tuna industry. Under this statute, the goal of zero mortality is satisfied by the application of the best available porpoise-saving techniques that are economically and technologically feasible.

The 1984 amendments to the MMPA set an overall quota of 20,500 porpoises, of which no more than 250 could be coastal spotted dolphins and 2,750 eastern spinner dolphins. In 1986 porpoise mortality rate accelerated for unknown reasons and by September the U.S. tuna fleet of 17 boats in the eastern tropical Pacific was expected to reach its limit months before the season was over. The National Marine Fisheries Service (NMFS) issued an emergency regulation, effective through 1986, prohibiting vessels from setting on porpoise. To enforce this order, NMFS established observer requirements and placed restrictions on the catching and landing of yellowfin and bigeye tuna in the ETP. (A more detailed analysis of the regulations governing the tuna industry is found in the section on legislation).

Next year there will have to be several changes in the tuna fishery permit in order to avoid a similar problem. Possible solutions might include greater observer coverage. Some believe that the number of dolphins that are reported killed is an underestimate of the actual mortality because not all vessels have observers. In addition there is great variation in porpoise mortality among vessels. Improvement in mortality rates might be achieved by having skippers with good records work with the those with high mortality rates.

Moreover, the number of dolphins killed does not include those that are seriously injured that will undoubtedly die but are counted as released alive. It has been calculated that the number of porpoises that are seriously injured equals about five percent of the actual kill. In addition, the effects on porpoise population structure due to the drowning of young and lactating animals are not fully understood. Further consideration should be given to these factors, in order to assess more accurately the impacts of the purse seine fishery on porpoise populations.

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U.S. RECREATIONAL FISHERIES

While information on commercial fisheries in the United States is collected on a regular basis, information on the nation's recreational fisheries is minimal. Few states require any type of saltwater recreational fishing licenses that could be used to determine the target species, area of operation and level of effort in this group.

To obtain some indication of the extent of the U.S. marine recreational fishing sector the Recreational Fishery Statistics Survey of the National Marine Fisheries Service has been compiling information from recreational fishermen on the type and level of species caught and the area of operation (U.S. Dept. Commerce 1986). Preliminary estimates for 1985 report 17 million fishermen participated in marine recreational fisheries in the Atlantic and Pacific Oceans and the Gulf of Mexico. They engaged in an estimated 70.8 million fishing trips and brought home an estimated 425 million fish.

The majority of the recreational fishing activity is concentrated in the Atlantic Ocean and Gulf of Mexico. The Gulf of Mexico was the most popular area in 1985 where recreational anglers engaged in 24 million fishing trips. The south Atlantic was second in popularity with 19.8 million followed by the mid-Atlantic (17.8 million) and the north Atlantic (8.7 million). The most frequent species caught in the Atlantic and Gulf was the winter flounder although in previous years bluefish and summer flounder represented the top species. Over 80 percent of the catch was made within 3 miles of shore.

Pacific coast fishermen engaged in roughly 10 million fishing trips with most of the activity concentrated in southern California. Catches were highest for Pacific mackerel and 60 percent of the fishing effort was conducted within 3 miles of shore.

The most popular type of fishing gear used by commercial fishermen is the traditional fishing pole, but an attempt to estimate the number of poles and amount of fishing line used would most certainly be futile.

INCIDENTAL TAKE/ENTANGLEMENT In a recent study to determine the types and sources of, and problems caused by, plastic debris in the marine environment, the Center for Environmental Education (1986) conducted a national assessment via personal communications with federal, state and local authorities in coastal areas. Although respondents reported a multitude of plastic debris items that are becoming increasingly prevalent in marine areas, plastic fishing line, the type used by recreational fishermen, is reported to be a nationwide problem. Fishing line, either when accidentally snagged on the bottom and lost, or purposely discarded in the marine environment, is causing countless numbers of marine wildlife to become entangled, crippled and killed nationwide.

In the New England region from Maine to Massachusetts ospreys are using monofilament fishing line as nesting material in which young birds become entangled and die (Blake pers. comm). However, this problem is not restricted to this region. In fact, reports of young ospreys strangled in monofilament line were received from many states along the eastern seaboard.

The entanglement of brown pelicans in monofilament line is a major problem in both California (Gress and Anderson 1983) and Florida. Most populations of brown pelicans are endangered. In the case of pelicans and other birds, if the monofilament does not cause immediate immobility, it often becomes snagged in trees and the birds are unable to break free. In Florida, the Suncoast Seabird Sanctuary on the west coast receives about 200 brown pelicans every year that have become entangled in fishing line (Suto pers. comm.). Many of these occurrences result from birds that attempt to eat bait from fishing hooks around piers and bridges over coastal waterways. Many more are never rescued after becoming entangled in trees where they die. Although most of the birds brought to the sanctuary are released, some are crippled for life.

Manatees have also been found entangled in fishing line in Florida. According to an official with the U.S. Fish and Wildlife Service in Jacksonville, this problem may be even more severe than scientists can document (Possert pers. comm.). Even alligators have been reported entangled in fishing line (Lebuff pers. comm.).

Sea turtle entanglement in monofilament fishing line is also a frequent problem. A recent compilation of reports of entanglement of sea turtles indicated that monofilament fishing line was a major cause (Balazs 1985). Although some cases may have resulted from encounters with tended gear, not one case reported a fishing hook attached to the line. Several cases involved a turtle that had become entangled in a line that was snagged on an underwater structure. Once the turtle became entangled it drowned. For some turtles, constricting line around limbs has led to necrosis of the limb. Even if a turtle does manage to carry the burden of fishing line it is likely that the animal will later become snagged on the bottom and drown. One leatherback turtle found in New York had ingested 180 meters (590 feet) of heavy monofilament fishing line (Balazs 1985).

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ENTANGLEMENT OF WILDLIFE IN PLASTIC DEBRIS

Not only do marine mammals, sea turtles and birds become entangled in active fishing gear, in recent years there has been increasing documentation of entanglement in lost or discarded fishing gear and other manmade items in the marine environment. Plastic debris is of particular concern because it is strong, lightweight and nonbiodegradable and therefore presents a persistent threat in the marine environment. Plastic debris such as lost or discarded fishing nets, rope, strapping bands used to bind packages, and domestic items such as sheeting, bags and six-pack holders have been documented to be involved in two basic types of interactions with marine wildlife: 1) the actual act of becoming entangled in debris, and 2) the ingestion of debris.

Entanglement

When an animal comes into either accidental or intentional contact with debris it may become entangled. Although some entanglements have been attributed to random encounters with debris during normal activities, there appear to be a number of factors that affect an animal's chances of becoming entangled. Accidental entanglements have been attributed to the inability of an animal to "see" plastic debris, especially fishing gear that is designed to be nearly transparent in water (Balazs 1985). Animals attracted to prey that congregate around floating objects or to prey entrapped in lost nets that continue to fish may also become accidentally entangled. Other encounters with debris may be deliberate. The propensity of pinnipeds and especially young pups to investigate floating debris has been repeatedly attributed to their curious and playful nature. But such curiosity may often lead to entanglement.

Pinnipeds appear to be most susceptible to entanglement. The list of pinniped species reported to be entangled in plastic debris in North America includes northern fur seals, California sea lions, northern elephant seals and harbor seals in California, Hawaiian monk seals and northern sea lions. Fragments of nets and plastic strapping bands have been reported to entangle almost all species of seals with the greatest frequency. Trawl net fragments, the most frequently observed item on northern fur seals, are usually of a mesh size large enough to slip over the head of a seal, but smaller meshes with tears in the webbing also present a threat.

The effects of entanglement on the survival of pinniped species is generally unknown, but for the northern fur seal, entanglement is believed to be a major cause of mortality. The Pribilof Islands of Alaska have a population of about 871,000 northern fur seals, 80 percent of the estimated total population of this species (Fowler and Kozloff 1985). Studies indicate that the fur seal population of the Pribilofs is less than half of that observed 30 years ago, and current trends indicate that this population is declining at annual rate of 4 to 8 percent per year (Fowler and Merrell 1986). Recently, the northern fur seal of the Pribilofs was designated as a depleted species.

With the extensive fisheries of the North Pacific, the average northern fur seal may encounter two to ten pieces of potentially entangling netting every year (Fowler and Merrell 1986). Plastic strapping is the second most common item found on seals. If a seal is not immediately immobilized by being entangled, the debris could ultimately prevent normal activities required for survival. The majority of entangled northern fur seals have had items of debris around their necks. This kind of entanglement, if constricting, may directly impair swimming or feeding abilities. Entangling debris also increases drag during swimming and, consequently, an entangled seal must use more energy to swim and therefore must consume more food to compensate. However, the drag caused by entangling debris would inhibit the high speed required for pursuit of prey items and may therefore lead to starvation. Young entangled fur seals reportedly have reduced growth rates compared to unentangled seals, and only 10% are expected to survive (Fowler 1985, Fowler et al. 1985). Entangled female seals may take twice the amount of time to forage for their pups, if they are able to return at all (Fowler pers. comm.). In addition, although the observation of scarred seals suggests that some animals may be able to rid themselves of this debris (Scordino 1985), others may not be as fortunate, and as they grow their synthetic "collars" can cause lacerations and open wounds susceptible to infection. Open wounds are more frequently observed on older seals, which may have encountered debris at an earlier age.

Up to 30,000 northern fur seals are estimated to become entangled each year (Fowler pers. comm.). However, these estimates are based on observations of entanglements on shore (Fowler 1982) and may actually be conservative (Fowler et al. 1985). While entangled seals are usually observed with only small fragments of net and pieces of debris, these seals are believed to represent only those individuals that have survived entanglement. The limited numbers of observations of entangled seals at sea have involved larger net fragments, in which most of the seals were found dead (Fowler and Merrell 1986). It is not known how many seals may become entangled and die, and subsequently drop out of these larger nets at sea without ever being observed.

Hawaiian monk seals, which are critically endangered, are also threatened by entanglement in debris carried by currents from the North Pacific fishing grounds to Hawaii. An analysis of incidents of entanglements since 1980 reported that about 30 seals have become entangled or have scars indicative of previous entanglements (Henderson 1985). The majority of these incidents have involved pups. Although no mortalities of monk seals have been positively attributed to entanglement in debris to date, one entanglement was probably fatal and six others would have been if the animals had not been rescued. Since the islands of Hawaii are surrounded by coral reefs, there is a serious threat of drowning posed to animals that may investigate debris snagged on underwater coral.

Sea turtles are also prone to entanglement because of their physical as well as biological characteristics (Balazs 1985). Fishing-related debris such as monofilament fishing line, trawl net, and gill nets have been most frequently involved in sea turtle entanglements (Table 17). As is the case for mammals, entangled sea turtles are unable to carry out basic behaviors such as feeding, swimming, and surfacing to breathe, and constricting debris may cause lesions or even necrosis of flippers. Leatherbacks and green turtles are especially prone to entangling their front flippers and heads in rope. Trawl net fragments floating at the surface have been described to "act like magnets" for sea turtles, which are attracted to sargassum mats and other natural floating masses that offer shelter and concentrated food sources.

Information on entanglement of birds in marine debris consists primarily of anecdotal accounts in literature. This issue tends to be overshadowed by the magnitude of seabird mortality in active fishing gear. Seabirds are attracted to the fish caught in nets, so that derelict nets, which continue to catch fish, will also entangle seabirds. One lost gill net found off Agattu Island, Alaska in 1981 measured 15 kilometers and contained approximately 350 dead seabirds (Jones and Ferrero 1985). Smaller net fragments, including the webbing from lobster pots, have also been reported to entangle birds (Bourne 1977).

Birds also become entangled in everyday domestic debris. Plastic six-pack rings, in particular, are commonly reported to entangle birds. Many birds actively collect pieces of nets and fishing line for nest material (see Recreational Fisheries) which can lead to the strangulation of both adults and juveniles. Although many of these incidents are considered to be rather infrequent there is no means by which this information is collected and monitored. There is clearly a need for networks or reporting systems such as those that already exist for sea turtles and marine mammals.

Table 17. Records of sea turtles entangled in fishing gear in Hawaii (Balazs 1985).

Date	Species	Location	Condition	Remarks
6/29/74	green	East Island	?	synthetic line and large float found entangled around the neck of turtle coming ashore to nest
12/76	green	Oahu	dead	found severely emaciated and entangled in rope. Died within a few days.
1/23/78	green	Punaluu, Kau	released	hand-captured by scuba diver with monofilament fishing line wrapped tightly around right front flipper producing deep wound.
1980	green	Johnston Atoll	dead	found tangled in a Japanese fishnet. Washed up near East Peninsula of Sand Island.
5/19/80	green	Trig Island	released	large piece of synthetic trawl found entangled around the neck of turtle lying motionless on beach. Net cut free.
4/81	green	Oahu	released	entangled in a piece of synthetic green trawl net floating offshore.
6/19/81	green	Oahu	1 released 1 dead	entangled in rope attached to abandoned anchor.
4/8/82	green	Lisianski Island	released	front flipper entangled in large piece of synthetic net snagged on reef flat close to shore. Necrosis at site of construction.
5/82	green	Midway Island	dead	found floating nearshore entangled in a piece of blue synthetic net. Deep cut in flipper.
4/18/82	green	Whale-Skate	dead	rib bones and metal flipper tag found entangled in scrap of synthetic trawl net washed ashore.

Table 17 (cont.) Records of sea turtles entangled in fishing gear in Hawaii.

Date	Species	Location	Condition	Remarks
6/23/83	green	Malaekahana	dead	decomposing carcass washed ashore with synthetic netting and line imbedded in neck
6/30/84	green	Tern Island	?	stranding with neck and left front flipper entangled in long piece of blue synthetic rope. Deep flipper abrasion from line.
6/7/84	green	Trig Island	released	heavy monofilament fishing line tightly entangled around left front flipper producing a deep cut.
10/8/84	green	Kahului, Maui	alive	front flipper tangled in buoy line of derelict, bottom fouled gill net. Swam off with piece of line still attached to it.
8/14/77	hawksbill	Oahu	dead	found entangled and decomposing in a lost but intact 600-foot-long monofilament gill net.
12/82	leatherback	Kailu-Kona	killed	entangled at night 2 miles offshore in an anchor. Turtle dragged boat around for several hours before being killed.

Table 17 (cont.) Records of sea turtles entangled in fishing gear in Hawaii.

Date	Species	Location	Condition	Remarks
7/20/81	olive ridley	Kailua-Kona	released	entangled in a large piece of synthetic trawl net floating several miles offshore.
7/29/82	olive ridley	Oahu	released	entangled in a piece of green synthetic net floating 6-7 miles offshore.
5/19/83	olive ridley	Hana, Maui	released	entangled in a 1.5 square meter piece of green synthetic net floating 1 mile offshore.
8/82	turtle sp.	Oahu	dead	vertebrae and ribs found tightly wrapped in a piece of trawl net floating about 10 miles offshore.
5/82	turtle sp.	West Molokai	?	entangled in a piece of green synthetic trawl net floating offshore.
1/1/82	turtle sp.	Waianae Harbor	alive	observed swimming entangled off Oahu in a piece of brown net. Likely to be a green turtle.

Ingestion of Plastic Debris

Along with the increasing reports of plastic debris in the marine environment there appears to be an increase in the documentation of plastic ingestion by marine animals. Certain animals may ingest plastics nonselectively while feeding on other organisms in the water column. Factors such as winds and currents that tend to concentrate planktonic food items also concentrate debris. On the other hand, floating items may actually resemble authentic food items. For seabirds, small plastic pellets and fragments may resemble small organisms or fish eggs or even the eyes of squid or fish. Sea turtles may mistake plastic bags and sheets for jellyfish, a favorite prey item for leatherback turtles (Balazs 1985). Plastic items covered with encrusting organisms such as algae and bryozoans may actually "smell" or "taste" like authentic food items. In addition, it has been suggested that hungry animals are less likely to discriminate among authentic food items and debris.

The effects of debris ingestion are not as well understood. The fact that plastic has not been found in the intestinal tracts or feces of birds suggests that it may be indigestible by these animals. Large quantities of ingested plastics may cause intestinal blockage, create a false feeling of satiation, or may reduce absorption of nutrients, thus robbing an animal of needed nutrition. Suffocation, ulceration and intestinal injury could result from the presence of jagged edges on plastics or the grinding of these items against intestinal walls. Long-term effects may result in physical deterioration due to malnutrition, decreased reproductive performance, and the inability to maintain energy requirements. Buoyancy caused by plastics in sea turtles could also inhibit diving activities needed for pursuit of prey and escape from predators. It has also been proposed that the absorption of toxic plasticizers (PCBs) may result from plastic ingestion, although this is still not well understood.

Records of cetaceans that have ingested debris are given in Table 18. The primary items ingested by cetaceans include plastic bags and sheeting although a sperm whale that had stranded in Oregon was reported to have approximately one liter of tightly packed trawl net in its stomach (Mate 1985). Because most information on debris ingestion by marine mammals is obtained from dead animals that have stranded, the actual cause of death is speculative. However, a captive dolphin in Hawaii (species unknown) was reported to have died as a result of ingesting a piece of membrane plastic (Uyehara pers. comm.). An infant pygmy sperm whale that stranded in Texas and was taken into captivity died apparently from ingesting a large plastic garbage bag, bread wrapper, and even a corn chip bag (Karivan pers. comm.).

Other reports of marine mammals ingesting plastic debris include a northern elephant seal and a northern sea lion that died from choking on styrofoam cups (Mate 1985). In 1985, a West Indian manatee found in Port Everglades, Florida, died from ingesting a piece of black plastic, possibly a bag, that had lodged in its pyloric valve (Laist pers. comm.). That same year another manatee death was attributed to debris ingestion; a 10 cm piece of stainless steel wire had pierced and ruptured the animal's stomach. In 1981, a manatee was reported to have ingested a rope. Rescue attempts consisted of tying the animal to a pole in the water by a 5 foot portion of the rope that extended out its mouth. Later, the rope was found tied to the pole but the manatee was gone (Possert pers. comm.).

Table 18. Records of cetaceans with plastic debris in stomach.

Species	Date	Sex	Length	Locality	Debris
Gervais beaked whale	12/18/83	F	371 cm	Cape May, NJ	bag
Striped dolphin	3/22/83	M	220 cm	Cape Point, NC	bag
Cuvier's beaked whale	1/?/81	F	580 cm	Assawoman, VA	bag
Dwarf sperm whale	12/4/74	F	170 cm	Corolla, NC	?
Dall's porpoise	7/2/73	M	222 cm	Santa Monica, CA	bag
Risso's dolphin	5/6/82	M	230 cm	Martha's Vineyard, MA	bag
Pygmy sperm whale	1/1/84	M	182 cm	Galveston, TX	bag
Pygmy sperm whale	5/17/85	M	320 cm	Brevard Co., FL	bag
Sperm whale	7/1/85	?	510 cm	Seaside, NJ	balloon
Minke whale	8/7/85	M	370 cm	Acoaxet, MA	bag

Source: Hare, Matt (pers. comm.). Marine Mammal Events Program, Division of Mammals, Smithsonian Inst., Washington D.C. Computer printout. Retrieved Feb. 11, 1986.

Sea turtles have been documented to ingest a wide variety of debris. While plastic bags and sheets are the most common item ingested (Balazs 1985) tar balls and plastic particles were also common. Specific reports of sea turtles ingesting plastic debris in the United States included green turtles found in Hawaii, Florida and Texas; loggerheads in Georgia, Florida, Texas, and Virgina; hawksbills in Florida and Hawaii; and leatherbacks in New York, New Jersey, Massachusetts, Virgina, Florida and Texas. In one case on Long Island, New York, a researcher reported that 11 of 15 dead leatherback turtles that washed ashore during a two-week period had plastic bags blocking their stomach openings. Ten of the turtles had ingested four 8-quart-sized bags, while one had eaten 15 bags.

For most species of turtles, with the exception of the leatherback, reports of immature turtles that had ingested debris are more frequent than reports of adults. However, immature leatherbacks are rarely seen. There has been growing concern over the mysterious "lost year" period for juvenile sea turtles when they are rarely seen by researchers. Recent findings indicate that these small turtles may concentrate to feed in the open ocean at areas of convergence and upon sargassum mats (Carr 1986). However, these areas not only concentrate food for these turtles, but also plastic debris.

To date, 50 species of marine birds worldwide are known to ingest plastic debris (Day et al. 1985). The most common plastic materials ingested are small (0.2-6 mm diameter) plastic pellets followed by plastic polyethylene fragments. Foamed polystyrene spherules are ingested less frequently. Plastic pellets are the raw form of plastic after it has been synthesized from petrochemicals (Coleman and Wehle 1984, Hays and Cormons 1974, Colton et al. 1974). They are transported in bulk to manufacturing sites where they are melted down and fabricated into plastic consumer goods. Although the precise source of these pellets has not been identified, they are assumed to come either from the effluent of plastic manufacturing and processing plants or from some point during shipment and transfer.

The tendency for birds to ingest plastic debris appears to be closely related to feeding habits. Diving birds have the highest incidence of plastic ingestion whereas plunging birds who sight prey from above the water surface, and birds who feed by taking food dropped by others are less likely to ingest plastics. Species feeding primarily on crustaceans or squid have been found to have higher frequencies of plastic ingestion whereas fish eaters are comparatively fewer.

Most birds also exhibit selective preferences for certain types of plastic in accordance with their color, shape or size and how these items resemble authentic prey. The parakeet auklet, for example, feeds primarily on planktonic crustaceans such as small round-shaped crabs. This species is found to ingest large amounts of light brown plastic particles that were classified as being "regular" in shape, primarily cylindrical, spherical, box- or pill-shaped and closely resembled its true prey in appearance.

Some species also feed plastic debris to their young. Of 50 Laysan albatross chicks examined on Midway and Oahu Island, Hawaii, 90% (45) contained plastic. The weight of plastic ingested varied from 1.0 - 175.0 grams, with a mean of 43.5 grams per chick (Fry and Fefer 1986).

While entanglement and ingestion of plastic debris has been shown to affect individual species, very little information is available on the broader impacts on marine populations, communities or ecosystems. To date, extensive research has only been carried out on northern fur seal populations. But among those species that appear to have the greatest degree of interaction with marine plastic debris, many are endangered or threatened species: Hawaiian monk seal, brown pelican, Kemp's ridley, hawksbill, leatherback, green and olive ridley sea turtles. The effects of plastic debris on these threatened and endangered species therefore should be closely monitored.

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LAWS APPLICABLE TO ENTANGLEMENT OF MARINE SPECIES IN ACTIVE FISHERIES

The incidental capture of marine mammals, seabirds, and sea turtles has been addressed by a number of legal approaches. Still other laws, which were not created for the specific purpose of addressing entanglement, may be applicable in prosecuting entanglements when they occur.

The first law to deal expressly with the incidental take of animals in an active fishery was the Marine Mammal Protection Act, passed in 1972, partly in response to the large numbers of porpoises that were being entangled and drowned in yellowfin tuna purse seine nets.

Marine Mammal Protection Act, 16 U.S.C. 1361 et seq. (MMPA)

The stated purpose of the Act is to "ensure that species and population stocks of marine mammals do not diminish beyond the point where they cease to be a significant functioning element in the ecosystem of which they are a part." This purpose is pursued in two ways: 1) a moratorium on all taking of marine mammals, with several major exceptions under which the moratorium may be waived, and 2) creation of the Marine Mammal Commission, which conducts research and policy analysis, reviews the condition of the stocks of marine mammals, and makes recommendations in support of conservation and protection measures.

The moratorium on taking of marine mammals is defined as a complete cessation of taking, and the term "take," is defined as "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." (16 U.S.C. 1362(12)). Under this definition, the entanglement of a marine mammal in fishing gear would constitute a "take," and be subject to prosecution with the attendant criminal and civil penalties set out in the Act. The moratorium section of the Act goes on, however, to carve out a number of exceptions for scientific and display purposes, and in the course of commercial fishing.

There are two ways the Secretary of Commerce may waive the moratorium on taking marine mammals during commercial fishing operations. One is through granting general permits under Section 101(a)(2). Section 103 sets out a process for regulations to govern incidental taking, and Section 104 describes the process for issuing permits for such taking. Under Section 101(a)(4) commercial fishing operations may be exempted from the permit process if their take of marine mammals is small and has a negligible impact on the population.

General Permits

General permits are issued to an entire industry, such as the permit issued to the American Tunaboat Association for its take of porpoise. In addition, individual domestic fishermen may apply for a Certificate of Inclusion to these general permits. The general permits also are issued to foreign fishing associations or embassies whose governments have a governing international fishery agreement (GIFA) with the United States, such as the International North Pacific Fishery Convention between the United States, Japan, and Canada. The Dall's porpoise permit issued to the

Federation of Japan Salmon Fisheries Cooperative Associations is an example of a general permit issued pursuant to a GIFA.

Both foreign and domestic permits can contain conditions for the specific fishery, including setting out provisions for research, reporting, gear and equipment requirements, and even fishing techniques, such as those described for the tuna purse seine fishery. Another type of permit condition is an allowance for "lethal take" in the case of predation of catch or damage to gear. Such provisions allow the holder of a certificate of inclusion under a general permit to kill a marine mammal, but only if it can be shown that there was repeated and significant damage to catch or gear, or that human life was endangered, and that all other non-lethal methods had been tried unsuccessfully to stop the animal from destroying the catch or damaging gear.

The process by which permits are granted consists of two procedures. The National Marine Fisheries Service conducts an evaluation of the permit, including a hearing, based on the application. At the same time, NMFS promulgates regulations, describing the permit and the conditions under which it is issued. There is public access to these parallel processes, which in recent years have been a forum for controversy, particularly in the case of the tuna/porpoise permit and the Japanese drift gill net Dall's porpoise permit.

For 1986, NMFS has issued or continued 12 foreign general permits that allow a total taking of 6,704 marine mammals. Table 19 lists the countries to whom these permits have been issued and the numbers and kinds of marine mammals permitted to be taken. The largest of these, permitting the take of 5,500 Dall's porpoise during salmon gill net operations by the Federation of Japan Salmon Fisheries Cooperative Associations, expires in 1986. The Federation has reapplied for a permit allowing the incidental take of the same numbers of marine mammals, but the outcome is questionable. Conservation groups have challenged the permit on a number of grounds, principally because prior conditions required a demonstrable reduction in the take of Dall's porpoise, and the Federation has not shown such a reduction.

There also are 10 domestic general permits, allowing a total taking of 26,925 animals each year (this includes the 20,500 porpoise allotted to the tuna purse seine fishery). These general permits are issued to classes of fishermen using specific types of gear. The categories provided for are towed or dragged gear, encircling gear involving intentional taking, encircling gear not involving intentional taking, stationary gear, and other gear. The fishery organizations that have permits at present are the American Tuna Boat Association, the North Pacific Fishing Vessel Owners Association, Pacific Coast Federation of Fishing Associations, and the Hawaii domestic fishery (permit for harassment only). After the general permit is issued, individual vessel owners apply for a certificate of inclusion, which allows them to take marine mammals under the general permit. Table 20 lists the general permits issued to domestic fisheries, except for the tuna fishery.

In 1984 Congress amended the MMPA, with the principal changes affecting the taking of porpoise in the tuna purse seine fishery. These changes require the tuna fishery to use the best available technology for the protection of marine mammals, adjust the continuing permit conditions to allow for new scientific information, and set specific quotas for spotted and spinner dolphins within the overall quota of 20,500.

The general permit to the American Tunaboat Association is the only permit that allows intentional taking of marine mammals in a fishery, and the only one to set up a federal observer program on a domestic fishery. Pursuant to provisions in the Act, regulations allow tuna fishing vessels to 1) take any marine mammals incidental to operations, and 2) intentionally take certain species according to specified quotas. (See Table 21). This latter provision is to allow the practice known as "setting on porpoise" to locate tuna. The regulations also go into great detail as to equipment, operations, and techniques to be used to encircle and attempt to release porpoises. A complex system of reporting is set up, including provision for observers on the vessels.

The purpose of the observer program is to ensure that tuna purse seine vessels do not "set on porpoise" after the quota is met, and also to gather data on the fishery. The regulations provide, however, that the observer program end as soon as the quota is met. This became a problem in 1986, when it appeared the fishery would take the quota of porpoise earlier in the season than expected. This would have left the fishery operating for several months longer, but without observers to insure that no vessels were continuing to set on porpoise.

In August, 1986, NMFS promulgated an emergency regulation that not only prohibited setting on porpoise after the quota was reached, but also prohibited the catching, possession, or landing of yellowfin and bigeye tuna unless the vessel voluntarily retained a NMFS observer aboard. The emergency regulation also prohibited the importation of foreign-caught tuna by vessels without observers. By mid-October, 1986, the agency declared the quota had been reached, and the provisions for voluntary retention of observers went into effect.

Small Take Exemption

Small Take Exemptions allow incidental taking of small numbers of non-depleted species of marine mammals by U.S. domestic fishermen. This exemption to the general permit requirements of the MMPA can be granted only if the total taking will have a negligible impact on the species or stocks involved and if a reporting system has been established among the fishermen involved (Marine Mammal Commission Annual Report, 1985).

Two of these small take permits have been issued, valid through 1988: the New England groundfish gill net fishery, and to the National Fish Meal and Oil Association for the menhaden fishery. (See Table 22). Guidelines for issuance of the permits include requirements for establishing a reporting system on incidental takings.

Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq. (FCMA)

The purpose of the FCMA is to conserve and manage the fishery resources found off the coasts of the United States and to promote sound conservation and management principles. The Act establishes a Fishery Conservation Zone (FCZ) which extends 200 miles seaward from the baseline of the territorial sea (16 U.S.C. 1821), and sets up a system of Regional Fisheries Management Councils which promulgate fishery management plans. Each state then promulgates its own fishing regulations consistent with these plans. Foreign fishing is provided for in the FCZ through issuance of permits to those nations which have GIFAs with the United States. These individual permits set terms and conditions on the foreign fishing effort.

While the FCMA is directed at fishery conservation, it does have two aspects which are applicable to the entanglement of marine mammals and birds: the requirement for observers aboard foreign vessels, and a prohibition against dumping gear into the ocean. It is not clear whether a state, in promulgating its own management plan, could include conservation and management measures for a particular fishery that were aimed directly at providing protection against entanglement of marine mammals and birds (Gosliner 1984).

Observer Program

No foreign fishing vessel may conduct fishing operations within the U.S. FCZ without a U.S. observer aboard. (16 U.S.C. 1821(i)(1)). The observers monitor the fishery take, and also keep reports of takings of marine mammals and sea birds. There is no comparable program for domestic vessels, except in the domestic yellowfin tuna fishery. However, foreign vessels conducting joint ventures with U.S. boats also are subject to the requirement for observers.

There are several potential problems with the observer program: lack of assurance that all animals caught are reported; the question of identification of the animals because ship's personnel may not be trained to do so; a shortage of observers (which means that not all foreign vessels have observers on board at all times), which limits the number of observer-reported animals in comparison to the total number actually being taken; reports by official U.S. observers may include only animals actually seen by the individual observer (Loughlin et al. 1983).

Disposal of Gear

Regulations promulgated to implement the FCMA also prohibit the intentional disposal of unwanted fishing gear by foreign vessels (50 C.F.R. 611.12(c) (1)(1985)). While the purpose of the regulation is mainly to avoid interference with fishing and vessels, it also lists "damage to any marine resource, including marine mammals and birds." Since the observer program would enable documentation of intentional disposals, enforcement of this provision is possible (Bean 1984). As with the observer program, however, there is no counterpart requirement for domestic vessels. NMFS presently is considering a proposal to amend all existing Fishery Management Plans to prohibit the disposal of gear at sea by both domestic and foreign fishermen (Gosliner 1984).

Endangered Species Act, 16 U.S.C. 1531 et seq. (ESA)

This law provides a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, and provides a program for the conservation of such endangered species and threatened species. (16 U.S.C. 1531).

The Act prohibits taking of any endangered or threatened species by any person subject to U.S. jurisdiction. The term "take" includes kill, trap, harass, pursue, hunt, shoot, wound, capture or collect, or to attempt to engage in any such conduct. (16 U.S.C. 1532). Therefore, if an endangered animal were entangled in a fishing net--even if it were to be released--the entanglement would be considered a "take" for purposes of the Act.

"Harm" is broadly defined in the regulations to include significant habitat modification or degradation where it actually kills or injures by impairing (50 C.F.R. 17.3), and has been construed by the courts to include indirect and unintended harm. (Palila v. Hawaii Dept. of Land and Natural Resources, 471 F. Supp. 985 (1979), aff'd, 639 F. 2d 495(1981).

Section 10 sets out procedures which would enable taking of endangered species incidental to otherwise lawful activity. This permit process is contingent on the development of conservation plans with mitigating measures, and which assure that the incidental taking will not jeopardize the likelihood of the survival and recovery of the species in the wild. (16 U.S.C. 1539(a)(2)(b)). No permit applications under Section 10 have ever been made for a fishery.

One analyst has suggested that the incidental take permit under ESA could provide an incentive to reduce entanglements, because it "legalizes what would otherwise be an illegal act punishable by substantial criminal and civil penalties" (Bean 1984). The argument points out that a permit with negotiated conditions, such as agreements not to discard gear, or to report sightings of lost gear, could be offered as an alternative to prosecution. The problem, however, is that the threat of prosecution is flimsy, in that with ESA, as with any of the wildlife laws or ocean dumping laws, enforcement is virtually impossible without actual observation of a violation.

Of the animals subject to entanglement, those that are endangered are the Hawaiian monk seal, Guadalupe fur seal, West Indian manatee, most of the great whales, several species of sea turtles, and the brown pelican. Unless a Section 10 permit had been granted, the prohibition against any taking would apply to entanglement of the above species in active fisheries, as well as in lost fishing gear. No permits could be issued for entanglements in discarded gear, because the permits apply only to takings incident to lawful activity. "If disposal of nets at sea is considered to be a violation of one or more of the aforementioned pollution control laws a permit could not be issued." (Gosliner 1984). Additionally, permits could not be issued if the endangered or threatened animal is a marine mammal, because in that case, the prohibitions against taking any depleted animal as set out in MMPA prevail (16 U.S.C. 1543). (The ESA requires that where another law is applicable, the more restrictive shall apply).

Section 7 of the Act provides for consultation among federal agencies about to engage in actions that may affect endangered species. "Actions" can include things as varied as federal construction projects, leasing, or even promulgation of regulations. Therefore, if federal fisheries regulations were to affect an endangered species, such as sea turtles in the Gulf of Mexico, the regulations would be subject to Section 7 consultation. (See "Discussion section" for an example of how Section 7 has been applied to allow incidental taking of endangered turtle (See also, Bean 1983.)

Migratory Bird Treaty Act, 16 U.S.C. 703 et seq. (MBTA)

The U.S. has treaties with Great Britain, the U.S.S.R., Mexico, and Japan for the purpose of protecting migratory birds. The treaty with Japan is the most illustrative in demonstrating the applicability of the MBTA to entanglement of seabirds in active fisheries.

The agreement with Japan, The Convention for the Protection of Migratory Birds and Birds in Danger of Extinction, and their Environment (25 U.S.T. 3329, TIAS 7990 (1972)) (Convention), was a recognition by both countries that migratory birds were a "natural resource of great value." (Preamble, 25 U.S.T. 3331). Article II of the Convention defines migratory birds, and the birds protected are listed in Annex I. Article III prohibits the taking of any of the listed species.

This flat prohibition against any taking has been modified by provisions in the Convention allowing taking for scientific research, protection of persons and property, and takings by hunting. Paragraph 2 provides for establishment of hunting seasons through promulgation of regulation by each of the contracting parties. The United States has established hunting seasons and limits on the taking of migratory game birds, as has Japan, but no takings of non-game species are permitted. Special provisions were included to permit taking for food and clothing by Eskimos, Indians and indigenous peoples of the Trust Territory of the Pacific Islands. (Article III, (e)). None of these allowable takings covers the incidental take in the course of fishing.

Of the 21 species of seabirds taken in the North Pacific salmon drift net fishery, 18 are listed in the agreement as protected birds for which no taking is permitted. One bird, the harlequin duck, is considered a "game" bird, and may be taken pursuant to hunting regulations; the two other non-game birds taken in the fishery, Cassin's auklet and dovekie, are not listed in the convention with Japan.

The Convention recognizes, as well, the delicate ecological balance of island environments, and provides that each party "shall endeavor to establish sanctuaries," (Art. III, Par. 3) and shall "seek means to prevent damage to such birds and their environment, including, especially, damage resulting from pollution of the seas." (Art. VI (a)). A serious consequence of the salmon fishery is the extremely high bird catch rate off the Aleutian Islands, where large concentrations of breeding birds are found. Additional seabird mortality results from the miles of lost or discarded drift net and other ocean debris generated by this fishery.

The Migratory Bird Treaty Act (16 U.S.C. 703 et seq.) implements the Convention with Japan. It provides that "Unless and except as permitted by regulations...it shall be unlawful at any time, by any means, or in any manner, to pursue, hunt, take, capture, kill, attempt to kill, attempt to take, capture, or kill...any migratory bird...included in the terms of the conventions...." (16 U.S.C. 703).

The Secretary of the Interior is authorized "to determine when and to what extent, if at all, and by what means, it is compatible with the terms of the conventions to allow...killing...of...[any bird subject to the conventions] and to adopt suitable regulations permitting and governing the same." (16 U.S.C. 704).

The principal permitted taking is for migratory "game" birds. Other permitted takings cover various scientific collection, rearing, banding, raptor and depredatory bird permits, none of which is applicable to the incidental taking of migratory seabirds in gill nets.

It does not matter that the drift net fishery does not set out with the purpose of taking birds. The MBTA prohibition against taking migratory birds has been broadly construed to include any taking, whether intentional or not. U.S. v. Corbin Farm Services, Inc., 444 F. Supp. 510, (D.C. Cal. 1978), aff'd 578 F. 2d 259; U.S. v. FMC, 572 F. 2d 902 (N.Y. 1978), U.S. v. Schultze, 28 F. Supp. 234 (1939). The courts have interpreted the legislative history to indicate an intent by Congress to protect migratory birds for their value, and "...it was not the intention of Congress to require any guilty knowledge or intent to complete the commission of the offense" of killing any migratory birds. U.S. v. Schultze, at 236. Further, prosecution is justified under the MBTA where the person in danger of taking migratory birds is reasonably in a position to foresee the danger and prevent it. U.S. v. Corbin Farm Services, Inc., at 535.

Although no prosecutions have ever been brought against the drift net fleet, the Office of the Solicitor for the Department of the Interior has acknowledged that "incidental take of migratory birds by Japanese fishermen, as well as United States citizens, is a violation of the MBTA...." (Memorandum on U.S.-Japan Migratory Bird Treaty, from Assistant Solicitor, Fish and Wildlife to Office of Migratory Bird Management, March 27, 1981.) The memorandum states the Department's opinion that the jurisdiction of the Act extends to U.S. territorial waters. It is arguable, however, that the Act can be applied extraterritorially based on 1) the U.S. claim of jurisdiction over natural resources in the Exclusive Economic Zone, 2) the de facto creation of an immunity for Japanese fishermen, and 3) cases and legislative history.

Another example of the applicability of the MBTA are the halibut and croaker gill net fishery off the coast of California. Threat of prosecution under the Act was used as an impetus to instituting changes in the fishery, which has been entangling thousands of common murres over the past several years. Rather than submit to wholesale prosecutions of fishermen for taking birds, the State of California agreed to regulate the fishery so as to essentially eliminate its impact on common murres. (See California Section, above).

However, while recognizing the Department of Interior's responsibility to enforce the Act, the U.S. Fish and Wildlife Service has stated that it and the U.S. Attorney General's office are "reluctant to criminally prosecute such cases...and it may be worth mentioning that prosecutions have apparently had very limited success in other areas where incidental take of seabirds has occurred...." (U.S. FWS 1985).

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Table 19. GENERAL PERMITS FOR FOREIGN FISHERIES IN US FCZ

FCZ/Applicant/Category	Otariidae						Phocidae				Cetacea		Total	
ATLANTIC OCEAN (Inside U.S. FZC)	Northern sea lion		Northern fur seal		California sea lion		Harbor seal		Elephant seal					
	Requested	Authorzied	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized
Japan I	5	0	0	0	0	0	5	5	0	0	20	15h/	30	20
Portugal I	0	0	0	0	0	0	20	20	0	0	20	20g/	40	40
German Democratic Republic I	0	0	0	0	0	0	8	8	0	0	10	10g/	18	18
Spain I	0	0	0	0	0	0	20	5	0	0	20	10g/	40	15
Italy I	0	0	0	0	0	0	20	5	0	0	20	15g/	40	20
Netherlands I	0	0	0	0	0	0	5	5	0	0	15	15g/	20	20
U.S.S.R. I	0	0	0	0	0	0	5	5	0	0	10	10g/	15	15
PACIFIC OCEAN (Inside U.S. FCZ)														
Japan														
Deepsea I	90	90	5	5	0	0	20	20	0	0	0	0	115	115
Hokuten I	45	45	5	5	0	0	5	5	0	0	0	0	55	55
Longline V	0	0	0	0	0	0	0	0	0	0	H	H	0	0
Salmon V	25	25	450	450	0	0	0	0	0	0	5,600	5,500d/	6,075	5,975
Republic of Korea I	100	95	0	5	0	0	100	25	0	0	50	5e/	250	130
Portugal I	40	40	0	0	0	0	20	20	0	0	20	20e/	80	80
Poland I	90	40	0	0	0	0	70	15	0	0	55	20e/	215	75
U.S.S.R. I	35	35	0	0	15	15	45	45	0	0	30	30	125	125
Totals	3,005 Pacific 5 Atlantic	2,500 Pacific 0 Atlantic	505	510	1,850	1,850	3,015 Pacific 183 Atlantic	2,285 Pacific 103 Atlantic	60	60	6,080 Pacific 415 Atlantic	5,775+ Pacific 358 Atlantic	14,515 Pacific 603 Atlantic	12,980 Pacific 461 Atlantic

NOTES:

a/ Dall's porpoise, harbor porpoise, and beluga whale.

b/ Pilot whales (30), harbor porpoise (0), Dall's porpoise (5), common (5), whitesided (5) and bottlenosed dolphins (5).

c/ Pilot whales (10), harbor porpoise (0), Dall's porpoise (10) and whitesided dolphins (10).

d/ Dall's porpoise.

e/ Except harbor porpoise.

f/ Harbor porpoise.

g/ Total cetacean take by all permit holders fishing in the North Atlantic Ocean may not exceed 622 common dolphins, 711 Atlantic whitesided dolphins, 365 harbor porpoise, 358 *Stenella* spp., 248 pilot whales, 234 grampus, 172 bottlenose dolphins, and 4 beaked whales.

h/ Pilot whales (5), harbor porpoise (5), and Atlantic whitesided dolphins (5).

H- Harassment Only.

ST- Small Take Exemption.

Source: Marine Mammal Commission Annual Report, July 1985

Table 20. GENERAL PERMITS FOR DOMESTIC FISHERIES IN US FCZ

	Otariidae						Phocidae				Cetacea		Total	
	Northern sea lion		Northern fur seal		California sea lion		Harbor seal		Elephant seal					
	Requested	Authorzied	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized
Domestic (HPFVO)														
I	1,000	1,000	10	10	0	0	10	10	0	0	10 [illegible]	10 [illegible]	1,030	1,030
III	500	300	5	5	0	0	200	200	0	0	10 [illegible]	10 [illegible]	715	515
IV	20	20	5	5	0	0	5	5	0	0	0	0	30	30
V	1,000	750	10	10	0	0	1,800	1,200	0	0	200e/	100	3,010	2,060
Domestic (PCFFA)														
I	10	10	5	5	20	20	10	10	10	10	0	0	55	55
III	0	0	0	0	100	100	25	25	0	0	60	50b/	185	175
IV	0	0	0	0	15	15	5	5	0	0	0	0	20	20
V	50	50	10	10	1,700	1,700	700	700	50	50	45	30c/	2,555	2,540
Domestic (Hawaii)	0	0	0	0	0	0	0	0	0	0	H	H	0	0

NOTES:

a/ Dall's porpoise, harbor porpoise, and beluga whale.

b/ Pilot whales (30), harbor porpoise (0), Dall's porpoise (5), common (5), whitesided (5) and bottlenosed dolphins (5).

c/ Pilot whales (10), harbor porpoise (0), Dall's porpoise (10) and whitesided dolphins (10).

d/ Dall's porpoise.

e/ Except harbor porpoise.

f/ Harbor porpoise.

g/ Total cetacean take by all permit holders fishing in the North Atlantic Ocean may not exceed 622 common dolphins, 711 Atlantic whitesided dolphins, 365 harbor porpoise, 338 Stenella spp., 248 pilot whales, 234 grampus, 172 bottlenose dolphins, and 4 beaked whales.

h/ Pilot whales (5), harbor porpoise (5), and Atlantic whitesided dolphins (5).

H- Harassment Only.

SI- Small Take Exemption.

Source: Marine Mammal Commission Annual Report
July 1985

Table 21. MARINE MAMMAL QUOTA FOR TUNA PURSE SEINE FISHERY

Quotas for each calendar year		Take	Encirclement	Mortality[1]
Species/stock	Management unit			
Spotted dolphin.	(northern offshore)[2].	16,570,000	10,338,000	20,500
Do	(southern offshore).	4,605,000	2,873,000	5,697
Do	(coastal)..........	202,000	126,000	[3] 250
Spinner dolphin.	(eastern)	2,222,000	1,386,000	[3]2,750
Do	(northern whitebelly).	1,205,000	699,000	5,321
Do	(southern whitebelly)[4].	568,000	329,000	2,506
Common dolphin.	(northern tropical)[5].	723,000	450,000	1,890
Do	(central tropical).	2,519,000	845,000	8,112
Do	(southern tropical).	1,306,000	421,000	4,045
Striped dolphin.	(northern tropical).	28,000	21,000	429
Do	(central tropical).	118,000	89,000	1,822
Do..............	(southern tropical).	265,000	199,000	4,095

Source: 50 CFR 216.24

Table 22. SMALL TAKE EXEMPTIONS

	Otariidae						Phocidae				Cetacea		Total	
	Northern sea lion		Northern fur seal		California sea lion		Harbor seal		Elephant seal					
	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized	Requested	Authorized
Domestic--New England Groundfish Gillnetters--ST	0	0	0	0	0	0	100	50	0	0	250 1/	230	350	280
Domestic--Menhaden Purse Seiners ST	0	0	0	0	0	0	0	0	0	0	50	33	50	33

Source: Marine Mammal Commission
Annual Report, July 1985

DISCUSSION

The incidental taking of marine animals in fisheries often reaches staggering levels, and for some populations of animals, incidental taking is a major threat to survival. With the rapid development of new fisheries and the expansion of existing fisheries in U.S. waters, incidental taking is likely to increase unless more effective means for reducing this problem can be developed.

There are numerous reports of entanglement of animals in active gear and debris, and many sources from private organizations and government agencies have expressed concern that so little is known. As many problems involve active operations fishing within state waters, and while these problems may entail making politically difficult decisions, there is clearly a need for more research and for the participation of state fish and game agencies. Unfortunately, very little research is being conducted by state agencies, in part because funding is restricted.

Most domestic fisheries continue to operate with little oversight. Unlike foreign fisheries in U.S. waters, most domestic fisheries are not monitored by observers. The major exception is the tuna purse seine fishery. A few fisheries with entanglement problems, such as the California halibut and croaker fisheries, operate with a voluntary monitoring program. Others taking animals under permit, such as the New England groundfish gill net fishery, have observers for research purposes. With these few exceptions, there is no process for verifying the levels of take reported by any domestic fishery.

In order to gather data on incidental take, one must rely largely on the permit processes mandated by the Marine Mammal Protection Act. Under the Act's provisions, fishermen can take small numbers of marine mammals under a "Letter of Exemption," or they can apply for a "Certificate of Inclusion" under a larger general permit issued to a particular fishery. From discussions with numerous officials and from data compiled in the course of research for this study, it is clear that the usefulness of these processes is highly debatable. It is true that these systems are virtually the only way currently available to gather any information on level of take, but the validity of the information obtained and the purpose for which the information is used is open to question.

Any system based on self-policing has the potential to foster abuse and legitimate error. In some areas a permit might be allowed for a certain species of cetacean or pinniped but not another. There may be a number of reasons why a fisherman does not identify protected species that are incidentially taken. Species taken may be misidentified, intentionally or not, or may be reported as "unidentified." In either case, such reporting provides little useful information. State and federal agencies should consider species identification programs for fishermen, especially those fishing in areas where it is important to distinguish species, such as where endangered species might be confused with non-endangered species.

In some instances, there appears to have been little effort to curb known reporting abuses by fishermen. Such is the case in the menhaden fishery, where all available information suggests that the menhaden fishery takes many more animals than are reported. In such cases, the National Marine Fisheries Service should place conditions on permits that would enable better monitoring of the levels of take.

Officials from the National Marine Fisheries Service (NMFS) admit that the general permit system for the Pacific fisheries, which covers thousands of fishermen, is virtually impossible to enforce. First, many fishermen have concluded in advance that they will be taking insignificant numbers of animals, so it is not necessary for them to apply for a Certificate of Inclusion. Therefore, even though the machinery to monitor the level of take is in place--i.e. the fishery has a general permit and the individual fishermen can apply to take animals legally—an unknown level of taking is occurring with no record.

Moreover, the general permit system may actually discourage the fishermen from reporting takings. In theory, a cumulative quota is set and no more takings are allowed after it is reached. This places considerable peer pressure on individual fishermen. Each taking reported by an individual brings the entire fishery one step closer to being shut down.

It might be useful, therefore, to design a system whereby each time a fisherman delivers his catch, a form concerning interactions with protected species is to be filled out. This should be done regardless of whether any taking actually occurred. Such a system would be especially important in areas where some taking is expected to occur based on available information.

The quota system may have other flaws. The National Marine Fisheries Service sets a quota on the number of takings of particular species. "Taking," as defined by the Marine Mammal Protection Act, includes not just the killing of an animal, but also capture (even if it is released), and harassment. Since the quotas generally don't distinguish between these types of takings, fishermen are probably much less likely to report an animal released alive or harassed; they might conclude that because these animals were still alive, the taking was not significant.

However, NMFS officials have stated that reporting may increase if fishermen recognize that NMFS does not intend to close the fishery as soon as the quota is reached. Futhermore, because NMFS believes that the quotas are conservative, exceeding the quotas will not pose a significant problem. From NMFS's point of view, the primary purpose of quotas is for gathering information rather than regulation. Given this, one if left to question the criteria used in setting quotas, and the purpose of quotas if they are not to be enforced.

There are a number of fisheries in which incidental taking has occurred illegally, but the fisheries agencies have been reluctant to take any action. For example, bottlenose dolphins are not permitted to be taken in any fishery, but there are numerous documented reports of the taking of this species. Until recently, the taking of harbor porpoises in California —perhaps as many as 300 per year—was allowed, although it is illegal. This negligence on the part of the federal and state agencies is particularly troublesome when endangered species are involved. In the shrimp industry, for example, no fisherman has been prosecuted for taking sea turtles even though incidental taking is the most serious threat to the survival of the critically endangered Kemp's ridley turtle. When existing technology exists to prevent such taking, as with the Turtle Excluder Device in the shrimp fishery, the failure to take action is even more disturbing.

In addition to these cases of unprosecuted incidental takings, there are numerous instances of fishermen killing animals that they consider to be pests or competitors. While some of these may be legitimate under permits issued under the Marine Mammal Protection Act (see legal section), the number of dead animals recovered with gunshot wounds leads to the conclusion that illegal killing may be widespread. Researchers studying seal carcasses in Oregon concluded that shooting was the leading cause of mortality for harbor seals (Stroud and Roffe 1979), and it is estimated that 400 sea lions are killed by gunfire in California every year (Sharpe 1983). State and federal officials acknowledge that regulations detailing the circumstances under which an animal may be shot legally are routinely ignored, and that federal reporting procedures are seldom observed. As one official from the National Marine Fisheries Service stated, "I'm afraid the fishermen often view their permits as a hunting license" (Sharpe 1983).

While there is often a legitimate need for fishermen to protect their catch from marine mammals, there is also clearly a need to ensure that allowances made for fishermen are not abused. Enforcement is a major problem, and officials cannot be expected to observe every vessel or investigate every case. However, closer attention should be paid to those fisheries where illegal intentional killing of animals has been reported or is suspected, and especially to those whose permits allow shooting. When the reports turned in by fishermen contain smaller numbers of animals killed than the agency would predict, greater enforcement efforts should be considered.

The management agencies sometimes take a rather creative approach in order to allow the taking of species for which routine permits cannot be issued. For example, Section 7(b)(4) allows the taking of an endangered species by a federal agency action provided that, after consultation with the Secretary of Commerce or Interior, it is concluded that the taking will not jeopardize the continued existence of the species, and the agency considers reasonable and prudent measures that will minimize and mitigate the impact of the taking. This provision was used in the past to allow a fishery in Hawaii to continue despite its adverse interaction with endangered sea turtles. More recently, the National Marine Fisheries Service has used Section 7(b)(4) to allow the incidental taking of endangered sea turtles in shrimp fisheries in the Gulf of Mexico. The agency has argued that, based on the findings of a biological opinion, the taking of turtles in the shrimp fishery would not jeopardize the continued existence of the species, and the use of reasonable and prudent measures could minimize the fishing impact on the turtles. It is questionable whether Congress ever intended that such an exemption process should be applicable to commercial fisheries. Although this provision of the Act has only been used twice in commercial fisheries, this could set a precedent for exempting other fisheries from prohibitions on taking of endangered and threatened species.

The taking of seabirds in fisheries, which is illegal under the Migratory Bird Treaty Act, underscores the many problems concerning data

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collection, legal responsibility, and philosophy. The principal problem is that the MBTA does not have the flexibility of other wildlife statutes to enable permitting of incidental take, conservation plans, or other regulatory schemes to minimize or reduce take. The Act's prohibition is an absolute one. There are no "ifs" included; the only federal action authorized would be prosecution. Given the reluctance to prosecute every taking of a bird, agencies have chosen instead to document incidental bird take for purposes of research, but under the guise of other statutes. For example, some information on bird bycatch is collected by observers in the Japanese mothership salmon fishery. However, these observers are placed on board pursuant to the Fishery Conservation and Managment Act and the Marine Mammal Protection Act (see legal section), for the purposes of monitoring the fishery and the incidental take of marine mammals. Further, even when observers are present, and have the authority to collect bird information, their principal training is in identifying marine mammals, not birds. Gathering data on seabirds is difficult because there may be a number of species that look alike that might be taken in a given area. In addition, immature or molting birds may be difficult to identify. The interpretation of the data is therefore less reliable when species may have been misidentified or are not identified at all.

Birds present an interesting legal case for the agencies involved: the Department of Commerce has jurisdiction over fisheries, and the Department of the Interior has jurisdiction over birds. Both agencies appear willing to argue that the other agency has jurisdiction when incidental taking is involved. Indeed, during review of the Japanese salmon permit, both the Department of Commerce and the Japanese fishing association argued that the taking of birds could not be a condition of the fishing permit. In recommending that the Secretary of Commerce grant the Dall's porpoise incidental take permit, both in 1981 and 1987, the Administrative Law Judges declined to make any recommendations about mitigating seabird mortality. They reasoned that the Secretary of Commerce is without jurisdiction under the MMPA or the MBTA to promulgate regulations concerning seabirds. In 1987, however, the judge called the seabird mortality "enormous" and "unacceptable", and suggested that the Department of the Interior mitigate this problem (Dept. of Commerce 1987).

Thus, there exists a major legal distinction between marine birds and mammals with regard to incidental taking. The Marine Mammal Protection Act contains provisions allowing non-depleted species to be taken incidentally. The Migratory Bird Treaty Act has no such provisions; any taking, regardless of the biological status of the species, is flatly prohibited. Nonetheless, even in situations in which taking has clearly affected breeding populations, the agencies have been reluctant to enforce the Migratory Bird Treaty Act.

In addition to this legal problem, the reluctance on the part of the agencies to grapple with the problem of birds probably results in part from an underlying attitude toward birds in general. First, because the species taken are generally not endangered species, the issue is not perceived to be important, even though the takings may involve hundreds of thousands of birds. Second, birds are taken in fisheries that may already be regulated because of incidental take problems involving marine mammals, and the management agencies may be reluctant to exacerbate the situation and provoke fishermen further.

Finally, public concern has played a large role in focusing the attention of the management agencies on marine mammals. In the last fifteen years, marine mammals and issues concerning their conservation have become increasingly prominent. Birds simply do not appeal to the public as much as marine mammals do. Even though the laws protecting birds have been in place for decades, there has not been the kind of public outcry over the drowning of seabirds that there was over dolphins dying in tuna nets. Without the constant vigilance of conservation organizations and other interested parties, it is unlikely that as much effort will be expended gathering information on birds and protecting them from incidental take as has been for marine mammals. These attitudinal differences may also be relevant to the apparent lack of concern with which sea turtle entanglement has been handled by management agencies.

Even without the deficiencies in structure or attitude discussed above, the ability to monitor incidental taking is greatly impeded by the slowness with which basic data on the fishery are compiled, on the one hand, and the rapidity with which fisheries are growing, on the other. Most data on fisheries in U.S. waters are already almost ten years old. Levels of take are set for a five-year period, but during that time, the fishery may have expanded dramatically. The fisheries are changing more rapidly than the levels of incidental take can be assessed. Compiling information on the fisheries is admittedly complex, however, a revision of the system by state and federal agencies should be considered so that statistics will not already be a decade old when they are released.

In the near future, the greatest change for fisheries in U.S. waters will be the phasing out of foreign fisheries. Although joint venture fisheries will continue, domestic fishermen will replace the foreign fishing operations in the U.S. Fishery Conservation Zone. Virtually the only direct observations on incidental take that are currently available come from the foreign fisheries. By the end of the century, and perhaps the end of the decade, unless the system is revamped, this information will no longer be available. Time is of the essence, and a solution may be pursued during reauthorization of the Marine Mammal Protection Act in 1988.

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GLOSSARY

anadromous--species of fish that mature in the ocean and then ascend streams to spawn in fresh water, including salmon, trout and striped bass.

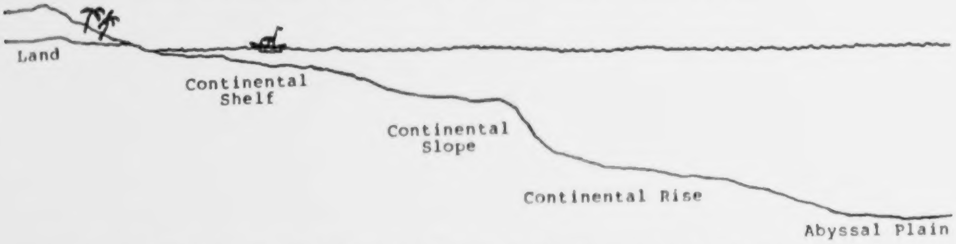
bottomfish--broadly interpreted as fish that are caught in or near the ocean floor, also referred to as **groundfish.**

cetacean--any of an order (Cetacea) of nearly hairless, aquatic mammals, lacking external hind limbs, but having paddlelike forelimbs: whales, porpoises and dolphins are cetaceans.

cod-end--the heavy mesh in the aftermost sections of a trawl net where fish accumulate during fishing.

commercial fisherman--an individual who derives income from catching and selling fish or shellfish taken from inland or marine waters.

continental shelf--the submerged shelf of land that slopes gradually from the exposed edge of a continent for a variable distance to the point where the steeper descent (continental slope) to the ocean bottom begins, commonly at a depth of about 600 feet.

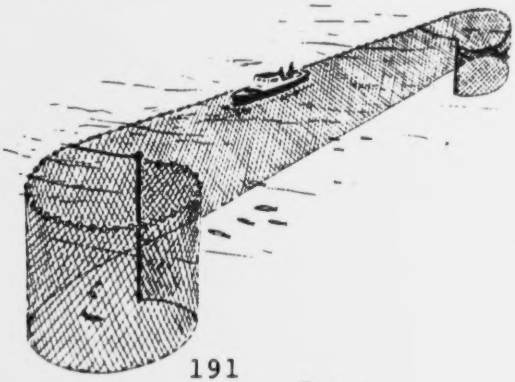


crustacean--various predominantly aquatic arthropods of the class Crustacea, including lobsters, crabs, shrimp and barnacles characteristically having a segmented body, an exoskeleton, and paired, jointed limbs.

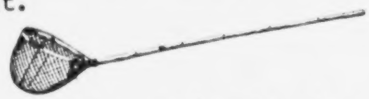
demersal species--dwelling on or close to the ocean bottom; benthic.

derelict net--abandoned net no longer attended by a fisherman.

drift net--a type of gill net that is not intentionally set, staked or anchored, but drifts freely with currents.



dip net--a small net attached to hand-held pole usually used by dipping it over the side of a boat.



domestic fishery--a fishery in which nationals of a country participate.

entanglement--the act of becoming tangled, wrapped or ensnared in an object so that escape is difficult.

estuary--a semi-enclosed body of water having a free connection with the open sea and within which seawater is diluted with fresh water from a river or land drainage.

exvessel price--price received by the harvester for fish, shellfish, and other aquatic plants and animals.

fathom--a measure of length or depth equal to 6 feet.

fishery closure--an order that fishing for a certain species cease for a certain time in a given area.

Fishery Conservation Zone (FCZ)--the area established by the United States contiguous to the territorial sea of the United States and extending seaward 200 nautical miles, measured from the baseline from which the territorial sea is measured.

fish fillets--the sides of fish cut lengthwise from the backbone.

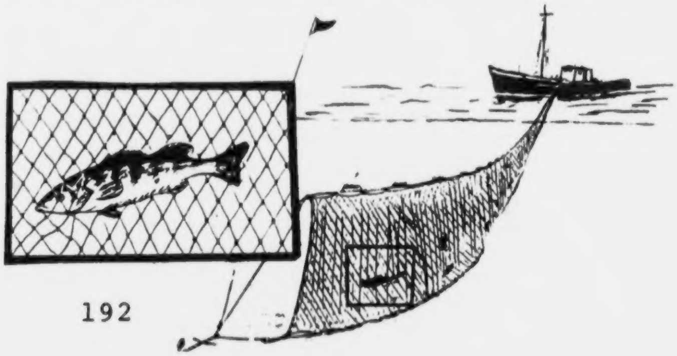
fish meal--a high-protein animal feed supplement made by cooking, pressing, drying, and grinding fish or shellfish.

Fishery Management Plan--a plan developed by a Regional Fishery Management Council to manage a fishery resource pursuant to the Magnuson Fishery Conservation and Management Act.

fixed--set in a stationary position by stakes, anchors or other mean as opposed to "drift."

flatfish--any of the order Pleuronectiformes (or Heterosomata) of fishes with a very flat body and both eyes on the uppermost side including flounder, sole, halibut and others.

gill net--a single sheet of webbing suspended vertically, hanging down into the water which is designed to catch fish by entanglement.



gross tons--the internal cubic capacity of all permanently closed space in and on a vessel. GRT, or gross registered tonnage, is expressed in tons or 100 cubic feet.

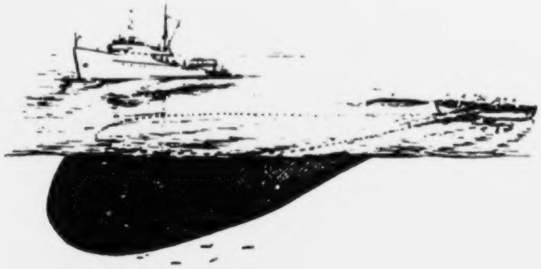
handlines--hand-held fish lines with a single or multiple hooks attached to one end.

incidental catch (incidental take)--anything other than the target species that is caught during a fishing activity (e.g. fish, birds, crustaceans).

inshore fishery--fishery that operates within coastal waters.

joint venture--any operation by a foreign vessel that assists fishing by U.S. flag vessels, including scouting, processing and/or support. A joint venture most often entails a foreign vessel processing fish received from U.S. flag vessels and conducting associated support activities. The fish received from the U.S. flag vessel are counted as part of the U.S. harvest.

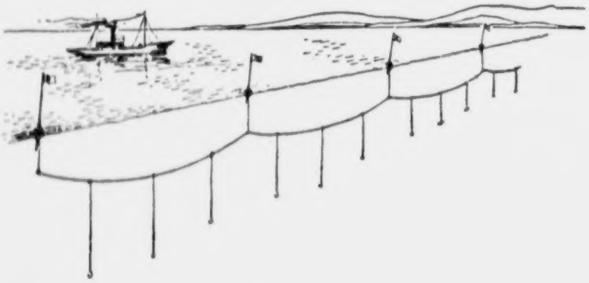
lampara nets--net used to encircle fish and shellfish from the sides and bottom.



landings--quantities of fish, shellfish, and other aquatic organisms measured in terms of weight, either whole or cleaned, brought ashore and sold.

leader--a length of net employed for guiding or diverting fish into a trap or larger net.

longline--a main fishing line which is supported by floats and from which baited hooks are suspended.



Magnuson Fishery Conservation and Management Act (MFCMA)--Public Law 94-265, as amended; sets out provisions governing U.S. fisheries and foreign fishing in U.S. waters. The Act provides for a system of regional councils which set specific regulations and allocations for each fishery in their areas.

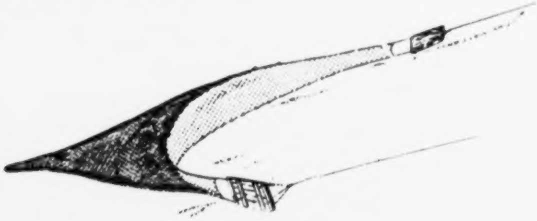
monofilament line--a single strand of line.

multifilament line--a line comprised of multiple strands twisted together.

observer--an agent of government who goes aboard a fishing vessel to oversee that fishing activities are conducted within the law.

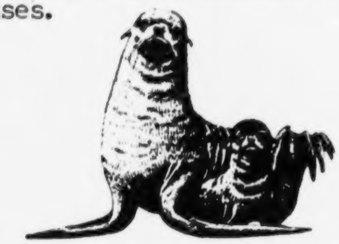
offshore fishery--a fishery generally characterized by larger vessels, capable of staying at sea for longer periods of time and operating in waters far from shore.

otter trawls--type of trawl net that uses otter boards or "doors" to spread the net mouth.



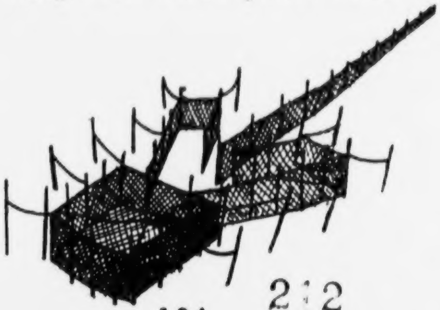
pelagic species--species which spend a significant portion of their life in or upon the sea.

pinniped--a suborder (Pinnipedia) of marine mammals having flippers, including seals and walruses.

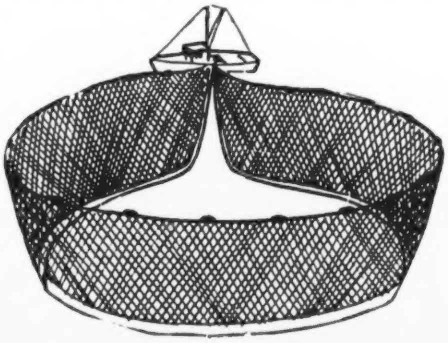


pot--portable structure designed and constructed to capture and retain fish and shellfish alive in the water; trap.

pound net--a large bag of netting supported by poles used for impounding fish. A series of nets hung from other poles divert fish into the pound.



purse seine--a floating net designed to surround fish and which can be closed at the bottom, or "pursed", by means of a free-running line through one or more rings attached to the bottom.

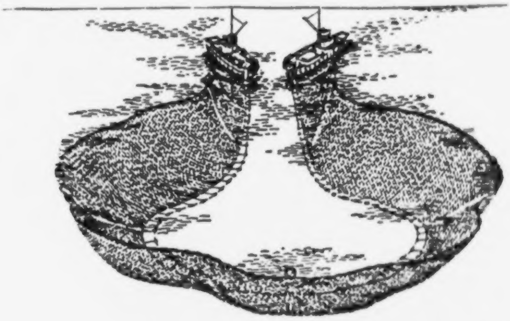


recreational fishing--fishing for pleasure, amusement, relaxation or home consumption.

round haul net--net that catches fish by surrounding schools from the sides and below, thereby preventing escape.

seabird--any avian species that spends a significant part of its life cycle in contact with the marine environment, including puffins, pelicans, albatrosses and others. Seaducks are classified under waterfowl in this report.

seine--any net set across the mouth of a bay or other restricted body of water where fish are impounded and accessible to capture.



set net--a type of gill net that has been intentionally set, staked, anchored, or otherwise fixed in a stationary position as opposed to "drift" nets.

Small Take Letter of Exemption--a document by which a group of U.S. citizens engaged in commercial fishing are allowed the incidental, but not intentional, taking of small numbers of nondepleted species or stocks of marine mammals under the Marine Mammal Protection Act of 1972 as amended in 1981.

stranding--the occurrence of a marine animal that becomes stranded on the beach.

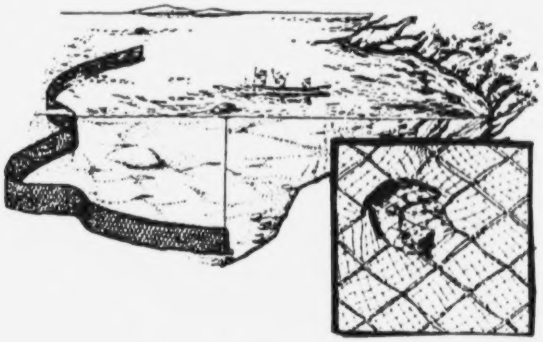
stretched mesh--the distance between opposite corners of a square of net mesh when stretched diagonally.

surimi--minced fish meat (usually Alaska pollack) which has been washed to remove fat and undesirable portions and mixed with cryoprotectants such as sugar and/or sorbitol to sustain quality during freezing often flavored and colored to imitate lobster, crab and other seafood.

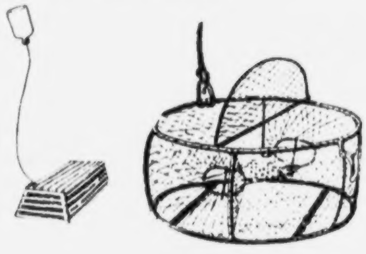
target species--a species intended to be captured.

territorial sea—a zone extending 3 nautical miles from shore for all U.S. states except Texas and the Gulf coast of Florida where the seaward boundary is 9 nautical miles.

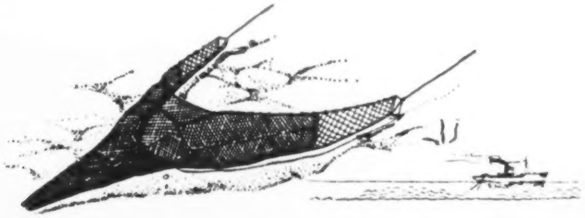
trammel net--type of gill net with three panels of netting suspended from a common surface line and attached to a single bottom line. The two outside panels are of a larger mesh than the inside panel.



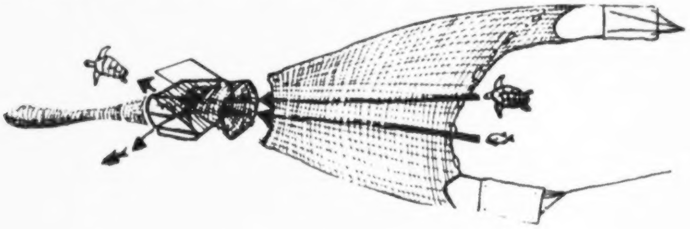
trap—a portable structure designed and constructed to capture and retain fish and shellfish alive in the water.



trawl—a large bag-shaped net towed behind a vessel to catch fish or shellfish.



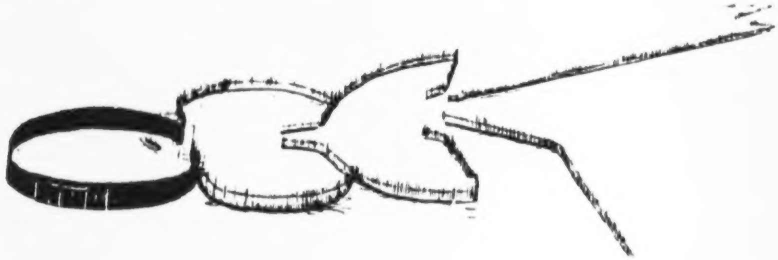
trawling efficiency device (TED)--a cage-like device that is placed in front of the bag or codend of a shrimp trawl. When large objects, such as turtles, large fish, or jellyfish enter the TED, they encounter bars slanting upward at a 45 degree angle. These bars force them up through a trap door and out of the shrimp net.



trolls—lines with lures or baited hooks which are drawn through the water from a vessel while in motion.

tub trawl—a vessel that uses galvanized tubs to hold longline gear.

weir--an enclosed area of netting into which fish are led by a barrier.

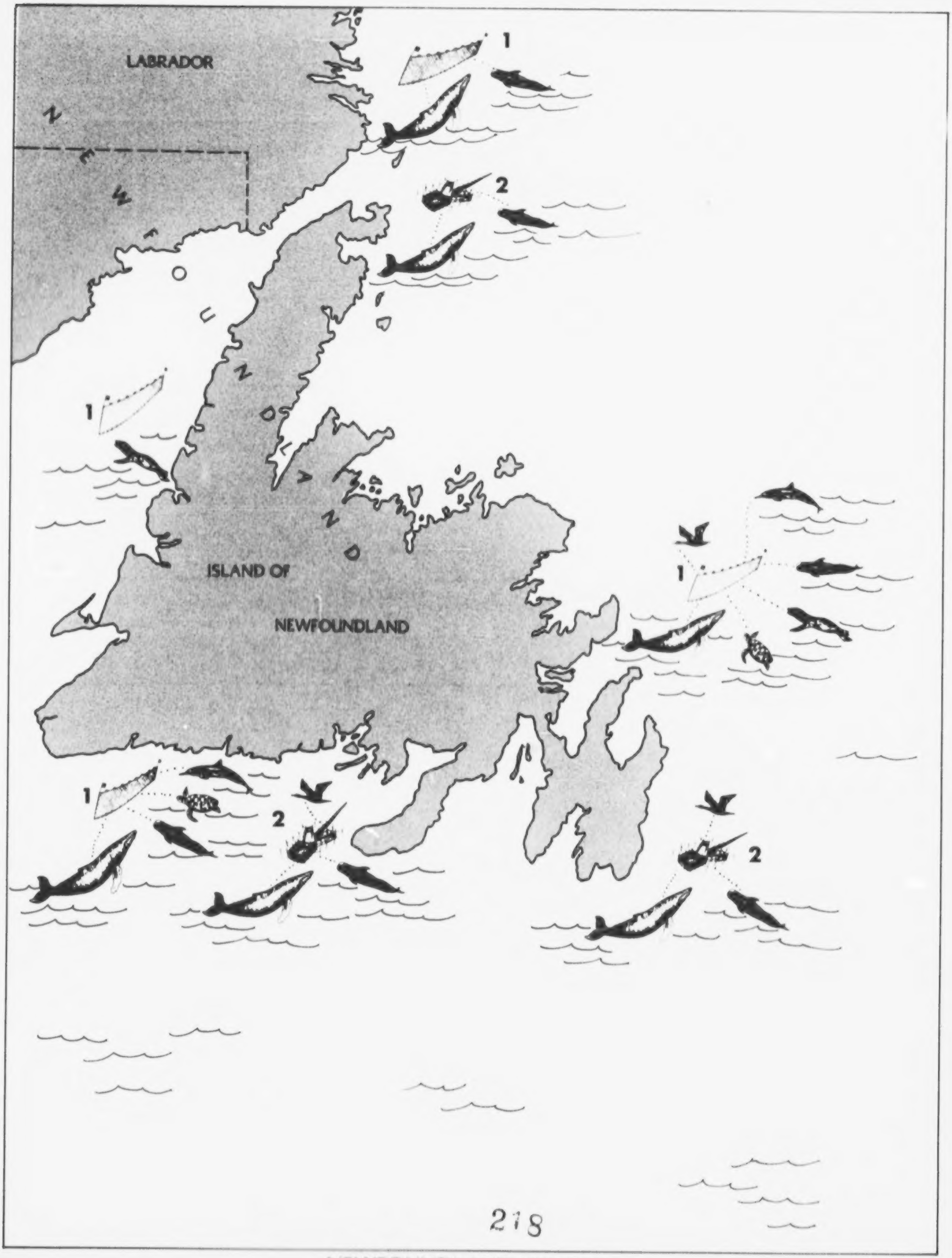


APPENDIX

Maps and Other Figures

NEWFOUNDLAND FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	Newfoundland Inshore Fishery	cod herring salmon other groundfish	gill net	inshore areas	humpback whale minke whale finback whale other whales Atlantic white-sided dolphin harbor porpoise other dolphins harp seal leatherback turtle common murre Atlantic puffin
2.	Newfoundland Inshore Fishery	cod herring salmon other groundfish	cod trap	inshore areas	(same as above)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NEWFOUNDLAND
ISLAND OF
NEWFOUNDLAND
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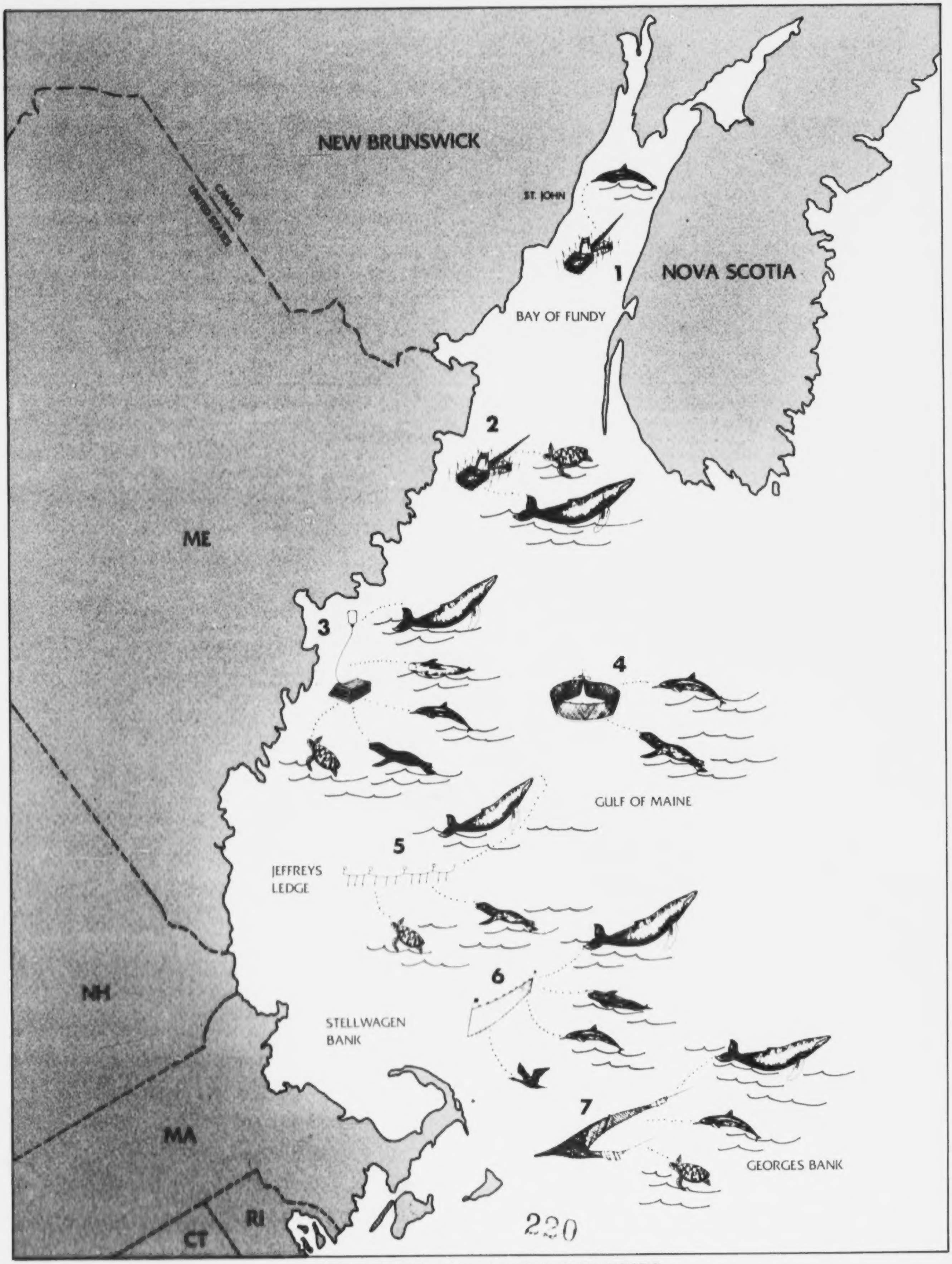
NEWFOUNDLAND FISHERIES

NORTHWEST ATLANTIC FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	New Brunswick Herring Weir Fishery	herring	weir	Bay of Fundy	harbor porpoise
2.	New England Atlantic Herring Fishery	herring	weir and seine	Coastal Maine	right whale humpback whale Kemp's ridley turtle
3.	New England Atlantic Herring Fishery	herring	purse seine	offshore in Gulf of Maine	harbor seal dolphin
4.	New England Lobster Trap Fishery	American lobster	trap	New England coastal and offshore waters	finback whale right whale sperm whale minke whale Risso's dolphin gray and harbor seals leatherback turtle cormorant osprey
5.	New England Tub Trawl Longline Fishery	groundfish	longline	Gulf of Maine	humpback whale leatherback turtle seals
6.	New England Groundfish Gill Net Fishery	cod pollack hake other groundfish	gill net	Gulf of Maine and Georges Bank	harbor porpoise harbor seal gray seal humpback whale right whale finback whale minke whale gannet, fulmar sooty shearwater
7.	New England Otter Trawl Fishery	groundfish	trawl net	Gulf of Maine Georges Bank	harbor porpoise humpback whale common dolphin Kemp's ridley turtle loggerhead turtle


NEW BRUNSWICK
CANADA
UNITED STATES
ST. JOHN
1
NOVA SCOTIA
BAY OF FUNDY
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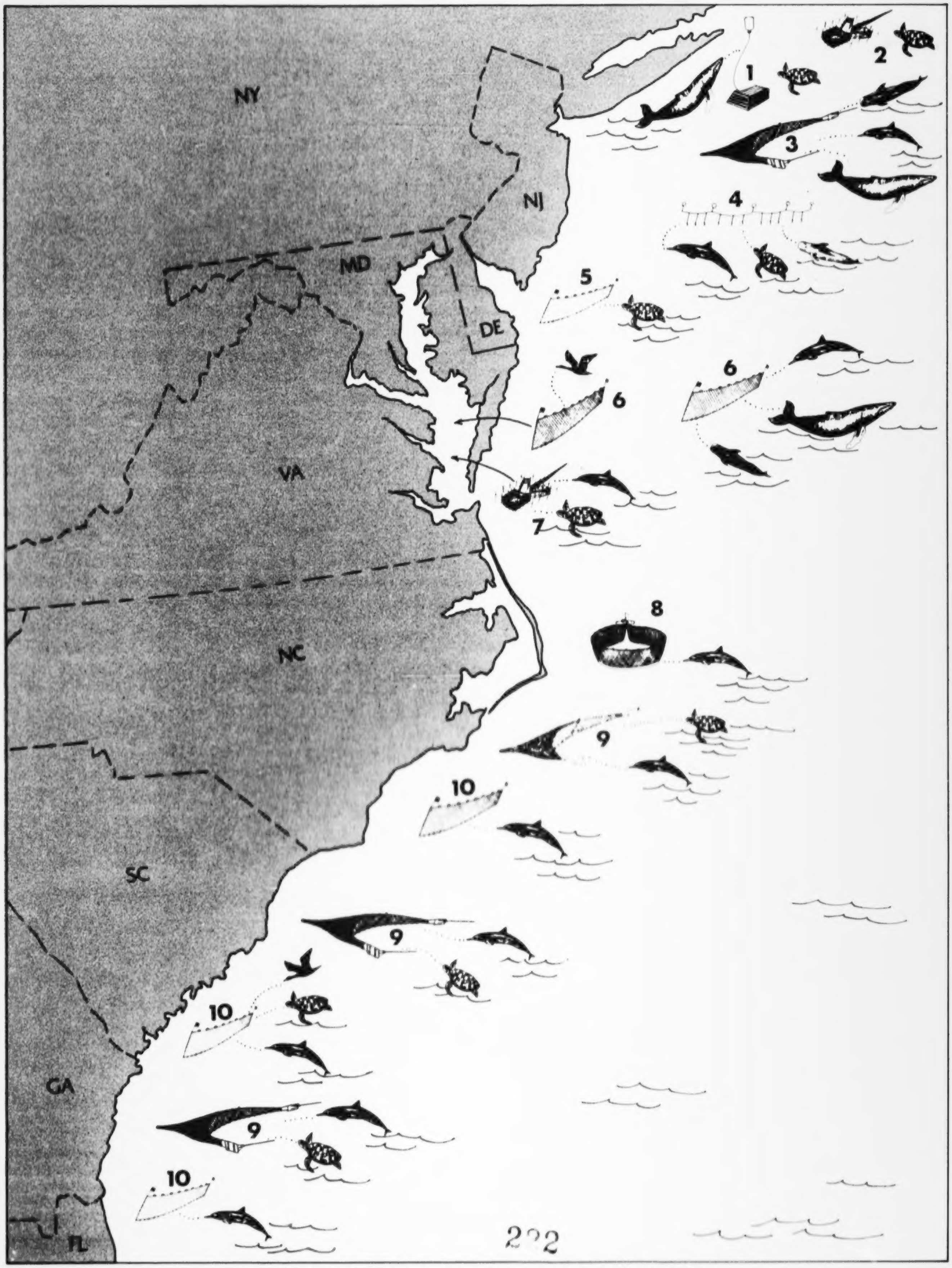
ME
3
4
GULF OF MAINE
5
JEFFREYS LEDGE
6
NH
STELLWAGEN BANK
7
MA
GEORGES BANK
RI
CT

NORTHWEST ATLANTIC FISHERIES

MIDDLE TO SOUTH ATLANTIC FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	New England Lobster Fishery	American lobster	trap	offshore New England to North Carolina	finback whale right whale sperm whale humpback whale leatherback turtle
2.	New York Pound Net Fishery	bluefish butterfish mackerel scup, porgy sea trout	pound net	coastal bays of eastern Long Island	Kemp's ridley turtle loggerhead turtle green turtle
3.	Squid and Mackerel Fisheries	squid mackerel	trawl net	Mid-Atlantic Bight	common dolphin pilot whales Atlantic white-sided dolphin bottlenose dolphin right whale Risso's dolphin
4.	Atlantic Swordfish Fishery	swordfish	longline	George's Bank to S. Atlantic offshore waters	bottlenose dolphin false killer whale loggerhead turtle
5.	Delaware Gill Net Fisheries	sea trout bass, croaker bluefish shad, perch sturgeon	drift gill net	offshore Delaware	loggerhead turtle Kemp's ridley turtle
6.	Chesapeake Bay Gill Net Fisheries	same as above	set and drift gill nets	Chesapeake Bay and offshore Virginia	humpback whale minke whale striped dolphin bottlenose dolphin harbor porpoise ruddy duck canvasback duck scaup
7.	Chesapeake Bay Pound Net Fishery	alewife bluefish croaker spot, bass sea trout perch	pound net	Chesapeake Bay	loggerhead turtle Kemp's ridley turtle leatherback turtle bottlenose dolphin
8.	South Atlantic Menhaden Fishery	menhaden	purse seine	South Atlantic	bottlenose dolphin
9.	Southeast Atlantic Shrimp Fishery	shrimp	trawl	Carolinas to Florida	loggerhead turtle green turtle leatherback turtle Kemp's ridley turtle hawksbill turtle bottlenose dolphin
10.	Carolina Gill Net Fisheries	shad sturgeon	set and drift gill nets	coastal waters North Carolina to Georgia	bottlenose dolphin harbor porpoise right whale loggerhead turtle green turtle Kemp's ridley turtle loon, scaup, grebe merganser, cormorant


NY
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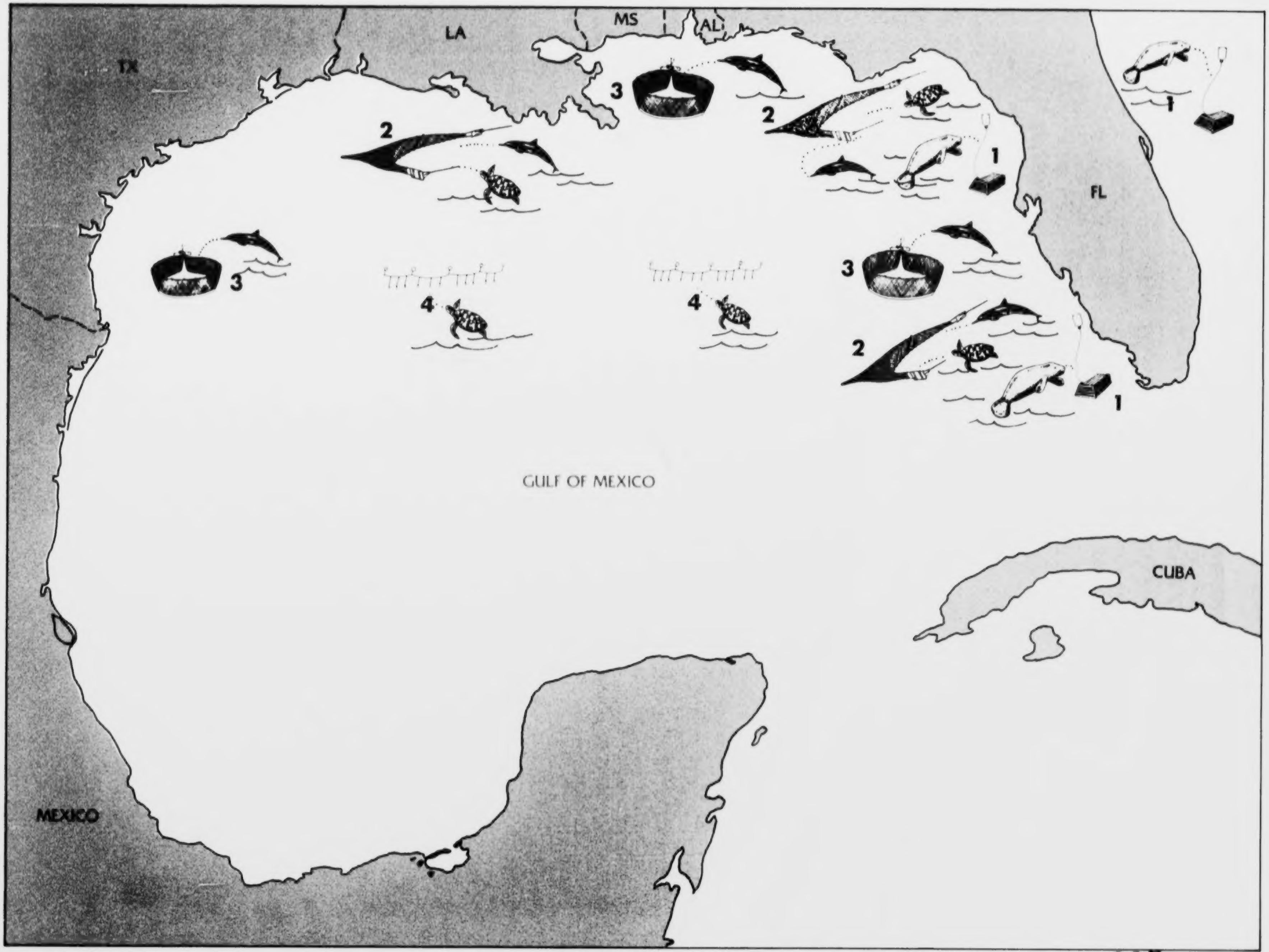
10

MIDDLE TO SOUTH ATLANTIC FISHERIES

GULF OF MEXICO FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Take
1.	Florida Crab Trap Fishery	blue crab stone crab	trap	coastal areas and inland waterways	West Indian manatee
2.	Gulf of Mexico Shrimp Fishery	shrimp	trawl net	Gulf of Mexico	loggerhead turtle green turtle leatherback turtle Kemp's ridley turtle hawksbill turtle bottlenose dolphin
3.	Gulf of Mexico Menhaden Fishery	menhaden	purse seine	Gulf of Mexico	bottlenose dolphin
4.	Gulf of Mexico Swordfish Fishery	swordfish	longline and drift gill net	Gulf of Mexico	leatherback turtle loggerhead turtle


LA
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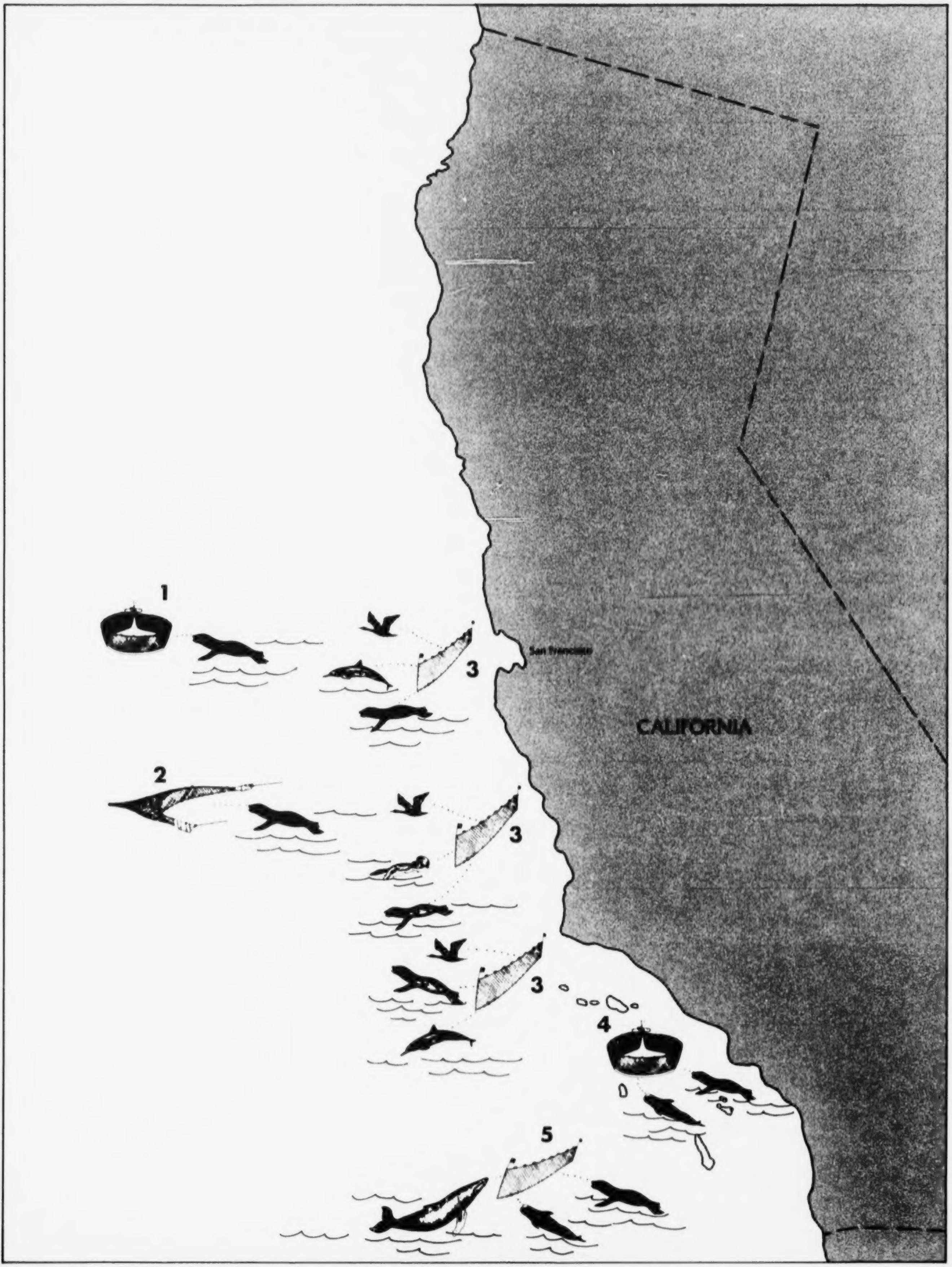
GULF OF MEXICO
CUBA
MEXICO

GULF OF MEXICO FISHERIES

CALIFORNIA FISHERIES

	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	Calif. Pacific Herring Fishery	Pacific herring	purse seine round haul net gill net	Bodega Bay Humboldt Bay Crescent City San Francisco Tomales Bay	Calif. sea lion
2.	Calif. Trawl Fisheries	shrimp rockfish hake	trawl nets	Central and S. Calif.	Calif. sea lion
3.	Calif. Gill and Trammel Net Fisheries	halibut white croaker white seabass rockfish other finfish	gill and trammel nets	Central and S. Calif.	harbor porpoise elephant seal harbor seal Calif. sea lion sea otter common murre sooty shearwater cormorant, grebe guillemot, loon marbled murrelet
4.	Calif. Squid Fishery	squid	lampara net purse seine	S. Calif. Monterey Bay	Calif. sea lion pilot whale
5.	Shark Gill Net Fishery	thresher shark bonito shark swordfish	drift gill net	S. Calif.	Calif. sea lion gray whale pilot whale finback whale


1
San Francisco
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CALIFORNIA
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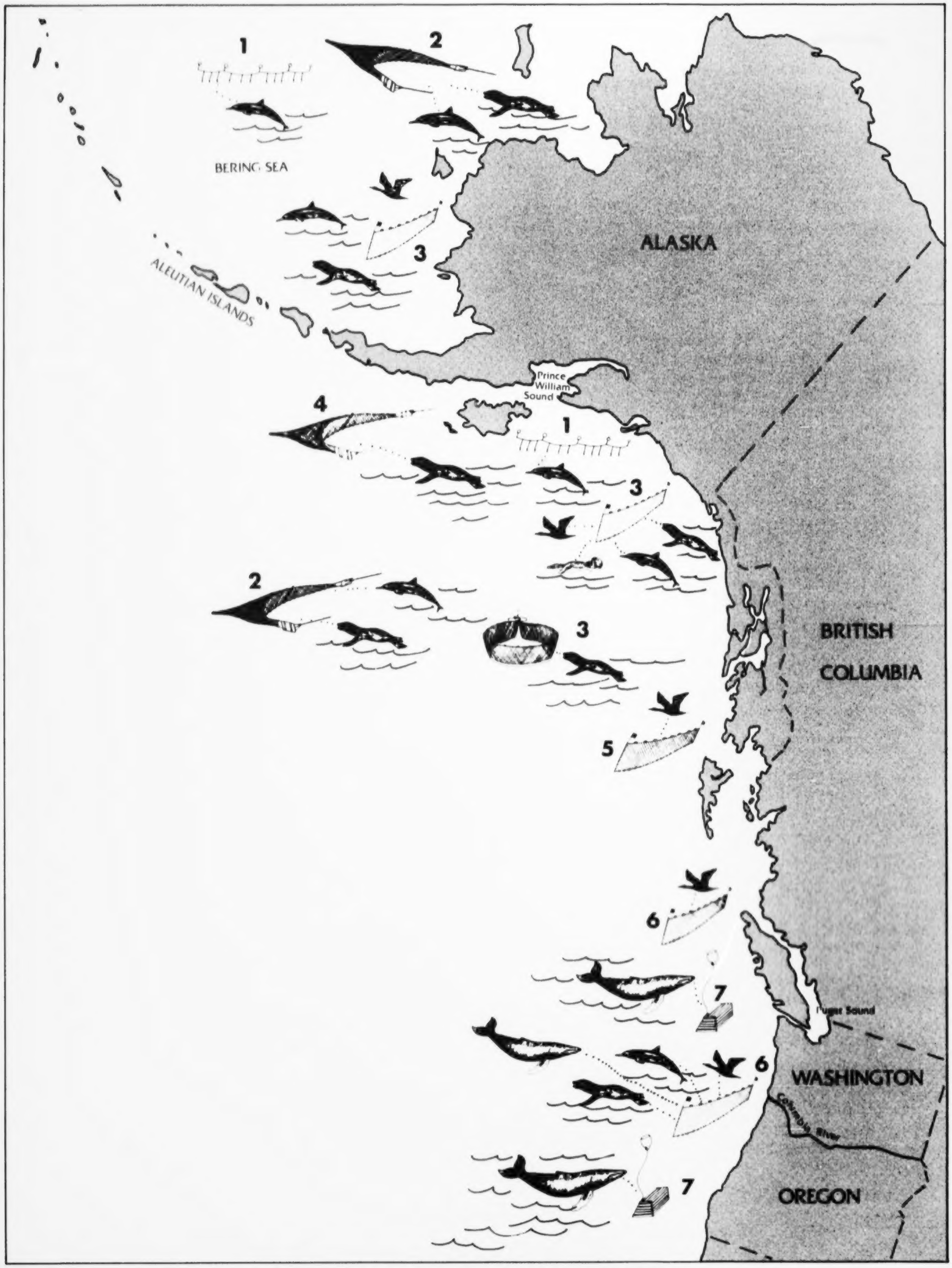
CALIFORNIA FISHERIES

NORTHWEST AND ALASKA FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	Alaska Sablefish Fishery	sablefish	longline and trap	Gulf of Alaska and Bering Sea	killer whale
2.	Alaska Groundfish Fisheries	pollock cod sablefish perch halibut mackerel flounder	trawl	Gulf of Alaska and Bering Sea	northern sea lion northern fur seal harbor porpoise ribbon seal northern elephant seal
3.	Alaska Salmon Net Fisheries	salmon	gill net	Copper River Prince William Sound Bristol Bay	harbor seal northern sea lion harbor porpoise Dall's porpoise sea otter beluga whale humpback whale marbled murrelet
	"	"	purse seine	"	seals
4.	Alaska Walleye Pollock Fishery	pollock	trawl net	primarily Gulf of Alaska and Shelikof Strait	northern sea lion
5.	British Columbia Barkely Sound Gill Net Fishery	salmon	gill net	Barkley Sound	marbeled murrelet common murre rhinoceros auklet
6.	Salmon Gill Net Fisheries	salmon	gill net	Columbia River Gray's Harbor Puget Sound	harbor seal California sea lion northern fur seal northern elephant seal gray whale harbor porpoise western grebe
7.	Dungeness Crab Trap Fisheries	dungeness crab	trap	coastal waters of Oregon and Washington	gray whale minke whale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BERING SEA
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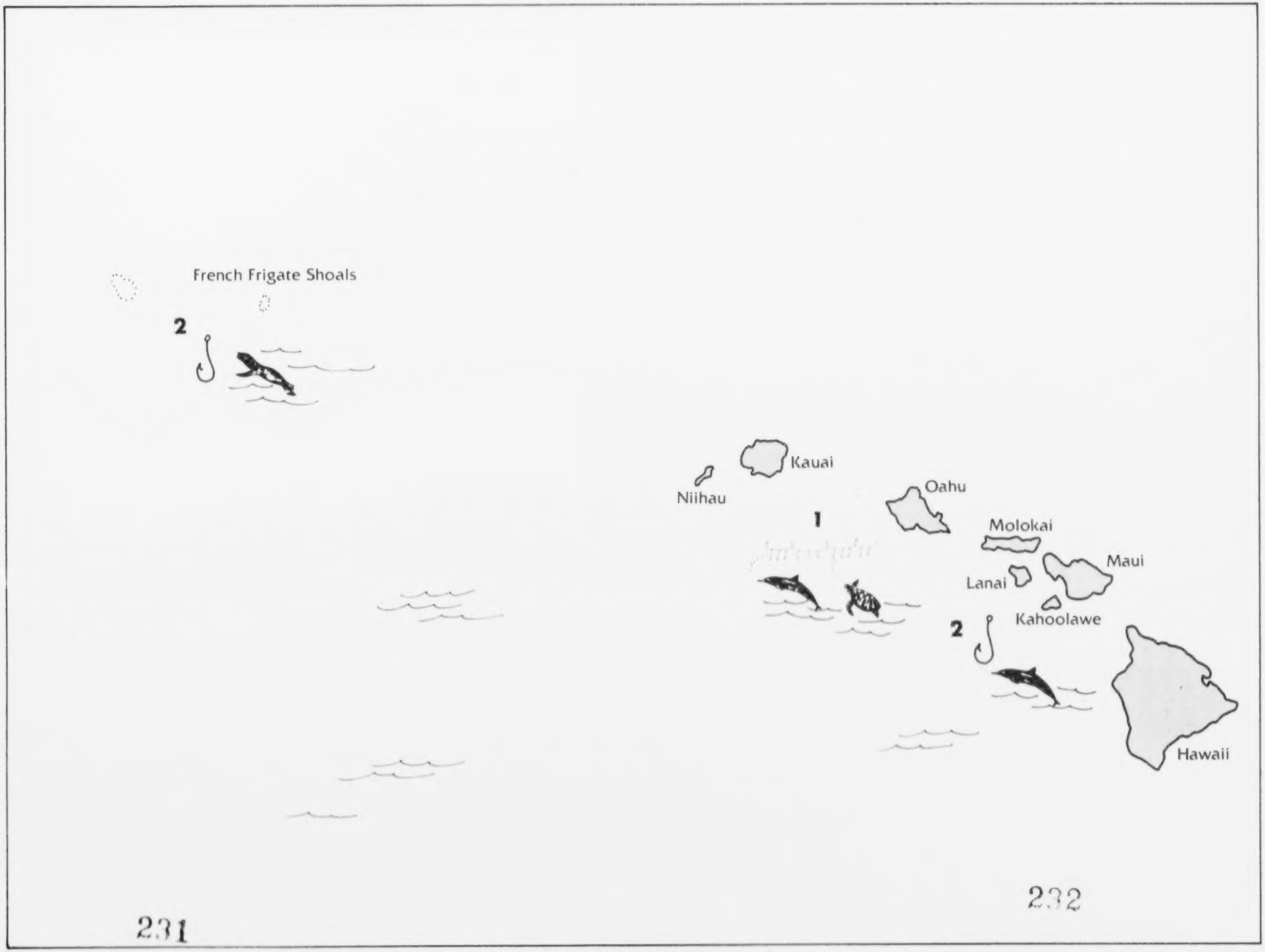
ALEUTIAN ISLANDS
ALASKA
Prince William Sound
4
1
3
2
3
BRITISH COLUMBIA
5
6
7
Puget Sound
6
WASHINGTON
Columbia River
7
OREGON

NORTHWEST AND ALASKA FISHERIES

HAWAII FISHERIES

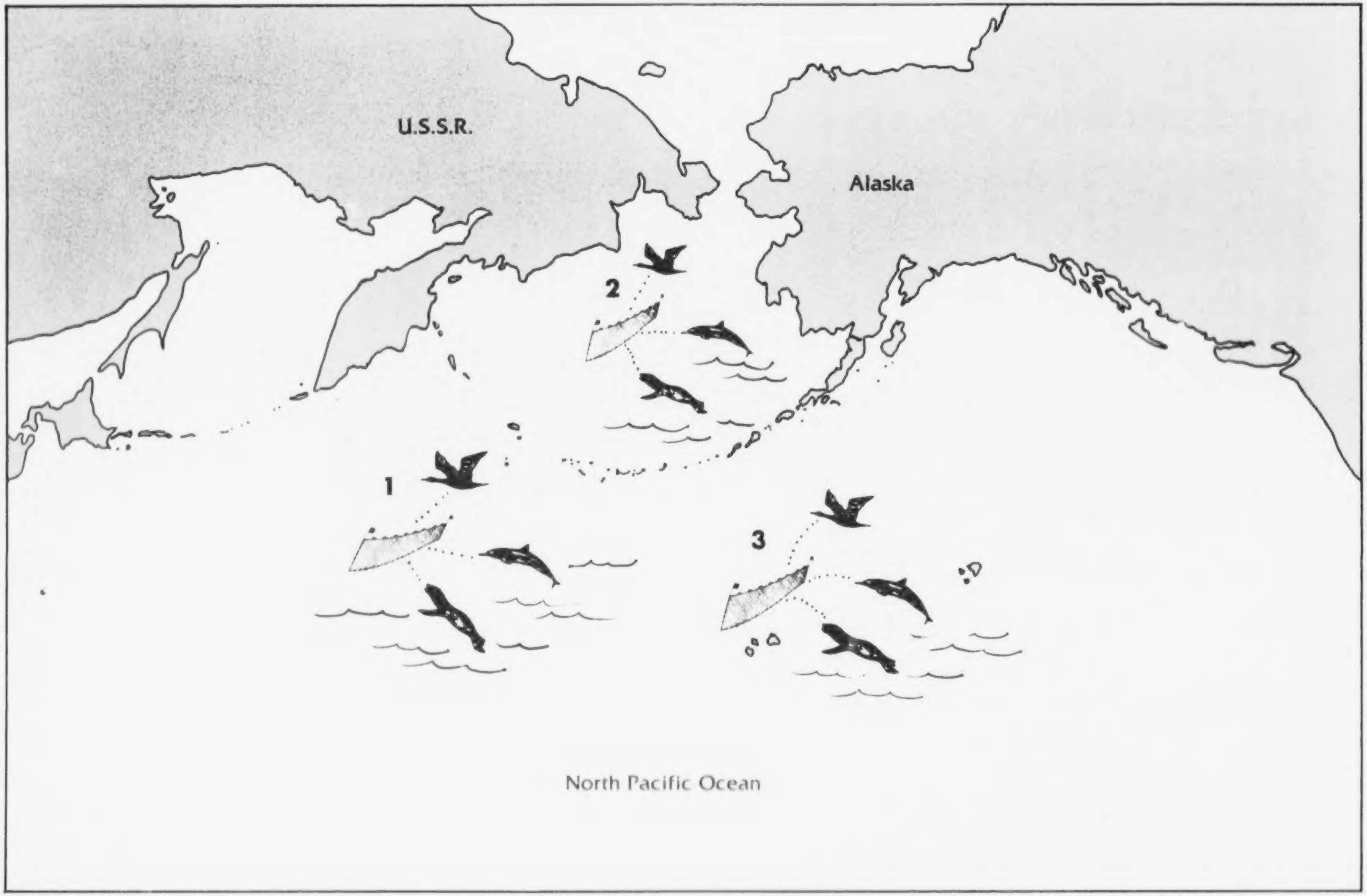
#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	Tuna Fishery	tuna billfish	longline handline trolling	primarily off main Hawaiian Islands	turtles Pacific bottlenose dolphin false killer whale
2.	Hawaiian Bottomfish Fishery	snapper sea bass jack amberjack	hook and line	main and Northwestern Hawaiian Islands	Hawaiian monk seal Pacific bottlenose dolphin


French Frigate Shoals
2
Kauai
Niihau
Oahu
1
Molokai
Maui
Lanai
Kahoolawe
2
Hawaii

HAWAII FISHERIES

HIGH SEAS DRIFTNET FISHERIES

#	Fishery	Target Species	Gear	Area of Operation	Incidental Catch
1.	Japanese Salmon Land-based Fishery	salmon	drift gill net	primarily north of 42°N lat. between 155°E and 175°E long.	Dall's porpoise northern fur seal common dolphin northern right whale dolphin Pacific white-sided dolphin northern sea lion seabirds
2.	Japanese Mothership Salmon Fishery	salmon	drift gill net	June 1-10: south of U.S. EEZ between 170° and 175°E long. About June 10: the fleet enters the U.S. EEZ if granted a permit After June 25: north of 56°N in Bering Sea outside U.S. EEZ	Dall's porpoise harbor porpoise Pacific white-sided dolphin northern fur seal northern sea lion 21 species of seabirds
3.	High Seas Squid and Billfish Fisheries	squid billfish tuna	drift gill net	Japan squid: between 40° to 46°N lat. and 170°E to 145°W long. Korea squid: between 34° to 47°N lat. and 141°E to 161°W long. Taiwan squid: between 33° to 46°N lat. and 155° to 161°W long. Japanese billfish: north of Hawaiian Islands	Dall's porpoise (presumed) seabirds (presumed)


U.S.S.R.
Alaska
2
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3
North Pacific Ocean

HIGH SEAS DRIFTNET FISHERIES

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